STUDIES RELATED TO WILDERNESS

WILDERNESS AREAS

MINERAL RESOURCES OF THE DOLLY SODS WILDERNESS AREA, GRANT, RANDOLPH, AND TUCKER COUNTIES, WEST VIRGINIA

GEOLOGICAL SURVEY BULLETIN 1483–A

Mineral Resources of the Dolly Sods Wilderness Area, Grant, Randolph, and Tucker Counties, West Virginia

By KENNETH J. ENGLUND *and* RALPH C. WARLOW, U.S. GEOLOGICAL SURVEY, *and by* JAMES J. HILL, PETER C. MORY, BRADFORD B. WILLIAMS, *and* MAYNARD L. DUNN, JR., U.S. BUREAU OF MINES

With sections on

Peat Resources

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Geochemical Survey

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Oil and Gas Potential

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STUDIES RELATED TO WILDERNESS–WILDERNESS AREAS

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An evaluation of the mineral potential of the area

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H. William Menard ***Director***

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STUDIES RELATED TO WILDERNESS

WILDERNESS AREAS

In accordance with the provisions of the Wilderness Act (Public Law 88-577, September 3, 1964) and the Joint Conference Report on Senate bill 4, 88th Congress, and as specifically designated by PL 93-622, January 3, 1975, the U.S. Geological Survey and U.S. Bureau of Mines have been conducting mineral surveys of wilderness and primitive areas. Studies and reports of all primitive areas have been completed. Areas officially designated as "wilderness," "wild," or "canoe" when the Act was passed were incorporated into the National Wilderness Preservation System, and some of them are presently being studied. The Act also directs that results of such surveys are to be made available to the public and submitted to the President and Congress. This report discusses the results of a mineral survey of the Dolly Sods Wilderness Area, West Virginia, which was established as a Wilderness by PL 93-622, January 3, 1975. The area is in the Monongahela National Forest in Grant, Randolph, and Tucker Counties.

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[Plates are in pocket]

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CONVERSION FACTORS

Metric unit		Inch-Pound equivalent
Length		
millimeter (mm)	= 0.03937	inch (in)
meter (m)	= 3.28	feet (ft)
kilometer (km)	= .62	mile (mi)
Area		
square meter (m^2)	= 10.76	square feet (ft^2)
square kilometer (km^2)	= .386	square mile (mi^2)
hectare (ha)	= 2.47	acres
Volume		
cubic centimeter (cm^3)	= 0.061	cubic inch (in^3)
liter (L)	= 61.03	cubic inches
cubic meter (m^3)	= 35.31	cubic feet (ft^3)
cubic meter	= .00081	acre-foot (acre-ft)
cubic hectometer (hm^3)	=810.7	acre-feet
liter	= 2.113	pints (pt)
liter	= 1.06	quarts (qt)
liter	= .26	gallon (gal)
cubic meter	= .00026	million gallons (Mgal or 10^6 gal)
cubic meter	= 6.290	barrels (bbl) (1 bbl=42 gal)
Weight		
gram (g)	= 0.035	ounce, avoirdupois (oz avdp)
gram	= .0022	pound, avoirdupois (lb avdp)
metric tons (t)	= 1.102	tons, short (2,000 lb)
metric tons	= 0.9842	ton, long (2,240 lb)
Specific combinations		
kilogram per square centimeter (kg/cm^2)	= 0.96	atmosphere (atm)
kilogram per square centimeter	= .98	bar (0.9869 atm)
cubic meter per second (m^3/s)	= 35.3	cubic feet per second (ft^3/s)

Metric unit		Inch-Pound equivalent
Specific combinations—Continued		
liter per second (L/s)	= .0353	cubic foot per second
cubic meter per second per square kilometer [$(m^3/s)/km^2$]	= 91.47	cubic feet per second per square mile [$(ft^3/s)/mi^2$]
meter per day (m/d)	= 3.28	feet per day (hydraulic conductivity) (ft/d)
meter per kilometer (m/km)	= 5.28	feet per mile (ft/mi)
kilometer per hour (km/h)	= .9113	foot per second (ft/s)
meter per second (m/s)	= 3.28	feet per second
meter squared per day (m^2/d)	= 10.764	feet squared per day (ft^2/d) (transmissivity)
cubic meter per second (m^3/s)	= 22.826	million gallons per day (Mgal/d)
cubic meter per minute (m^3/min)	=264.2	gallons per minute (gal/min)
liter per second (L/s)	= 15.85	gallons per minute
liter per second per meter [(L/s)/m]	= 4.83	gallons per minute per foot [(gal/min)/ft]
kilometer per hour (km/h)	= .62	mile per hour (mi/h)
meter per second (m/s)	= 2.237	miles per hour
gram per cubic centimeter (g/cm^3)	= 62.43	pounds per cubic foot (lb/ft^3)
gram per square centimeter (g/cm^2)	= 2.048	pounds per square foot (lb/ft^2)
gram per square centimeter	= .0142	pound per square inch (lb/in^2)
Temperature		
degree Celsius (°C)	= 1.8	degrees Fahrenheit (°F)
degrees Celsius (temperature)	$=[(1.8\times °C)+32]$	degrees Fahrenheit

MINERAL RESOURCES OF THE DOLLY SODS WILDERNESS AREA, GRANT, RANDOLPH, AND TUCKER COUNTIES, WEST VIRGINIA

By KENNETH J. ENGLUND and RALPH C. WARLOW,
U.S. Geological Survey, and by JAMES J. HILL, PETER C. MORY,
BRADFORD B. WILLIAMS, and MAYNARD L. DUNN, JR.,
U.S. Bureau of Mines

SUMMARY

The Dolly Sods Wilderness Area includes about 4,134 hectares within the Monongahela National Forest, Tucker, Grant, and Randolph Counties, W. Va. The area is in the Allegheny Mountain section of the Appalachian Plateaus and is at the extreme eastern edge of the Appalachian coal region. Dolly Sods, the source of the area name, is an upland meadow that was used for the summer grazing of cattle by early settlers. All surface and mineral rights are held by the U.S. Forest Service.

About 490 m of sedimentary rock of Late Mississippian to Late Pennsylvanian age crop out in the trough of the broad, gently folded Stoney River syncline. The basal 213 m of the exposed rock sequence is characterized by an abundance of grayish-red shale, silty shale, and siltstone that are distributed along the lower valley slopes bordering Red Creek and its major tributaries. The rest of the exposed stratigraphic section is a coal-bearing sequence of sandstone, siltstone, shale, and underclay that includes prominent cliff- and ledge-forming conglomeratic sandstone beds.

Coal, the principal mineral resource of the Dolly Sods Wilderness Area, is of low- to medium-volatile bituminous rank and is found in at least seven beds. Of these, four beds are of sufficient thickness and extent to contain coal resources, which total about 36 million metric tons. Coal reserves, estimated to be approximately 4.7 million metric tons, are limited to two beds. Development of the coal resources of the Dolly Sods area consists of several shallow adits, which provided fuel for locomotives during early logging operations, and one abandoned truck mine.

Peat, shale, clay, sandstone, and natural gas are potential mineral resources in the area but are of minor commercial interest. Evidence of economically important metallic deposits was not found during this investigation.

INTRODUCTION

The Dolly Sods Wilderness Area comprises approximately 4,134 ha (hectares) in the Monongahela National Forest, Tucker, Grant, and Randolph Counties, W. Va. (fig. 1). It is about 18 km west of

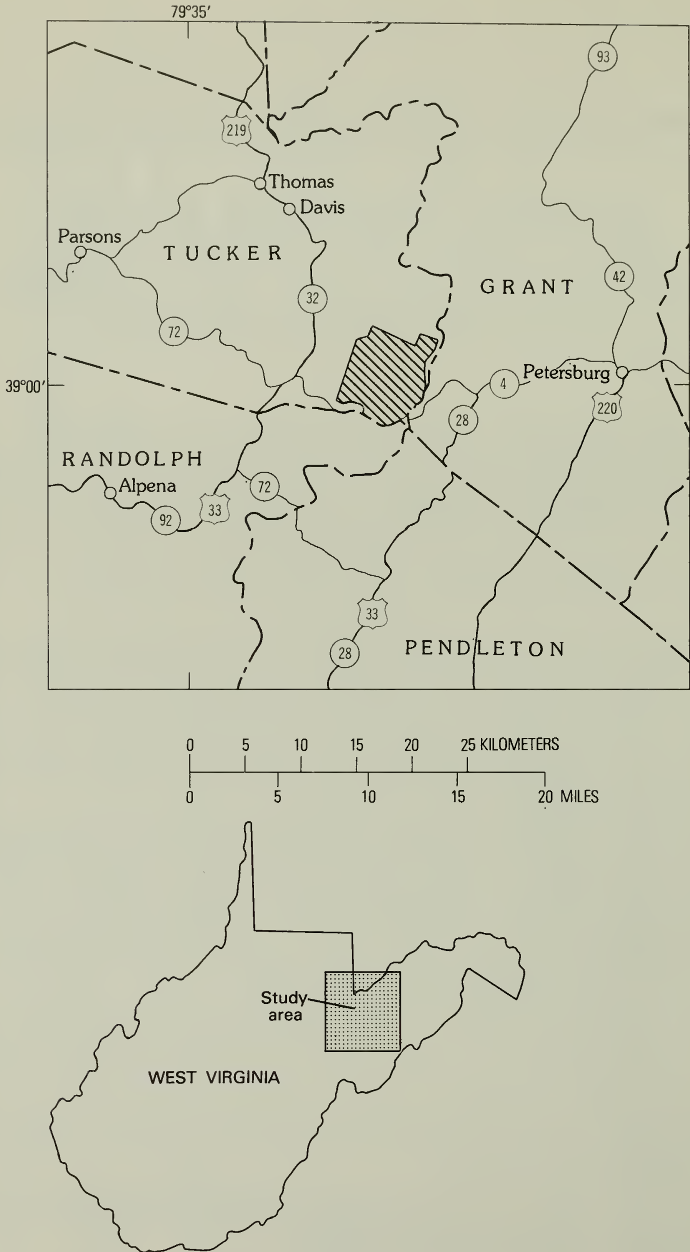

FIGURE 1.–Location of the Dolly Sods Wilderness Area, W. Va.

Petersburg, W. Va., and can be reached by several improved roads: Forest Service Route 19 provides access from the south, Forest Service Route 75 parallels the eastern boundary, and the northwestern corner is accessible by State Routes 32 and 37 and by Forest Service Route 80. From these Forest Service roads, well-marked trails extend into the interior.

The area is in the Allegheny Mountain section of the Appalachian Plateaus physiographic province and at the eastern edge of the Appalachian coal region (fig. 2). Altitudes range from about 790 m on the lower part of Red Creek to more than 1,250 m on the mountain tops. The topography is varied and includes highland bogs, canyons deeply incised by Red Creek and its tributaries and broad upland plateaus fringed by cliffs of conglomeratic sandstone (fig. 3). Picturesque water falls are formed by resistant sandstone beds along Red Creek and its tributaries.

Types of vegetation vary from those found in open bogs and grasslands to those of heath associations, various hardwood timberlands, and conifer woods; the conifer woods include red spruce and plantings of red pine (fig. 4).

LAND STATUS

Under authority of the Weeks Act of 1911, the Forest Service purchased the four tracts of land that make up the Dolly Sods Wilderness

FIGURE 2. – View northeast along Allegheny Mountain, showing conglomeratic sandstone and typical vegetation.

FIGURE 3.–Massive conglomeratic sandstone in the Roaring Creek Sandstone of White (1903) in the Kanawha Formation.

FIGURE 4.–Bog in northeast corner of the Dolly Sods Wilderness Area.

Area. By 1929 all surface rights in the area were in Federal ownership (fig. 5). The largest tract was purchased from the Bridges Estate in 1916; mineral rights were reserved by the vendor. Another tract was purchased from the Parsons Pulp and Lumber Co. in 1916, and it had a mineral reservation that expired in 1936. Remaining tracts – the Clara Rightmire and the Heavner and Turner Dolly – were purchased in 1923 and 1929 respectively; the vendors had no outstanding mineral rights.

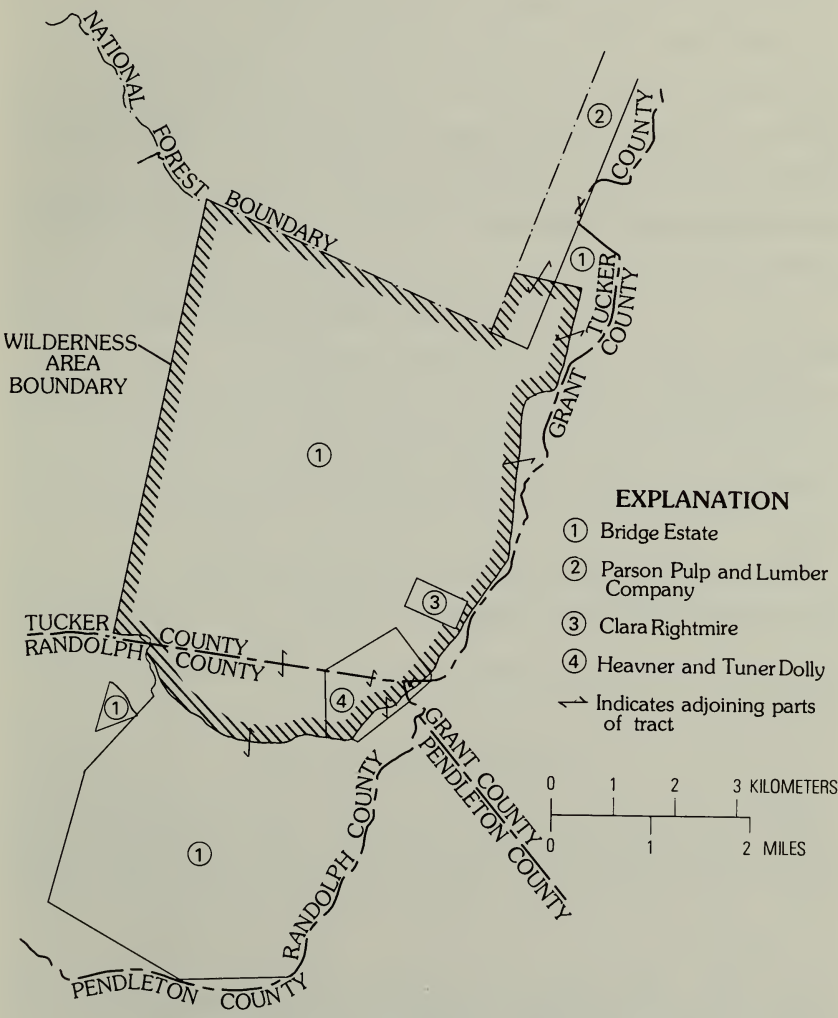

FIGURE 5. – Land tracts in the Dolly Sods Wilderness Area.

After purchase, the land units that now make up the Dolly Sods Wilderness Area and adjoining national forest lands were managed under Forest Service principles of multiple use. Fire protection and restoration were stressed in management practice.

In June 1969, a citizen's committee studied the Dolly Sods area and offered ideas and suggestions for classification and management. A proposal and management plan to classify the Dolly Sods area as a scenic area and that incorporated the results of public input was submitted to Forest Service authorities in September 30, 1970. This classification was approved on October 30, 1970.

At that time, mineral rights under most of the Dolly Sods Scenic Area were in private ownership. For proper Forest Service management of the scenic area, it was essential to rejoin the subsurface and surface ownership. Therefore, purchase of the mineral rights was given highest priority (U.S. Forest Service, 1970).

The Nature Conservancy of Arlington, Va., optioned and later purchased (deed dated September 1, 1972) mineral and mining rights under 6,296.46 ha in Tucker and Randolph Counties from the West Virginia Coal and Timber Co., Inc. This was done to hold mineral rights in abeyance from development until Congress appropriated money to the Forest Service to purchase these interests.

An appraisal of the mineral estate held by the Nature Conservancy was conducted by the Forest Service with regard to potential purchase. A Forest Service appraisal dated December 4, 1972 (see footnote 2), substantiated the value of the mineral estate. Minerals were purchased and conveyed to the Federal government in a deed dated December 19, 1972.

Subsequent to establishment of the Dolly Sods Scenic Area, Public Law 93–622 enacted by Congress on January 3, 1975, established the Dolly Sods area as one of 16 "instant" wilderness areas in the East. Surface and subsurface ownership is now vested in the Federal government.

PREVIOUS INVESTIGATIONS

Early investigations in the vicinity of the Dolly Sods Wilderness Area include geologic mapping (Darton and Taft, 1896) and coal-bed mapping (Ashley, 1920). These studies were followed by comprehensive county reports of the West Virginia Geological Survey that described the distribution, quality, and quantity of coal resources in Grant (Reger and Tucker, 1924), Randolph (Reger, 1931) and Tucker Counties (Reger and others, 1923). Unpublished reports that evaluated the resource potential of the Bridges Estate were prepared for the Forest

Service by J. B. Ferguson and Co.[1] and M. M. Marshall.[2] Peat deposits along the Allegheny structural front were described by Cameron (1970).

PRESENT INVESTIGATIONS

Field investigations by the U.S. Geological Survey consisted of reconnaissance geologic mapping and data collecting by K. J. Englund and R. C. Warlow during late October 1975. This study included the measurement of stratigraphic sections and the tracing of coal beds and resistant sandstone units. Additional subsurface information was provided by three shallow core holds (Reger and others, 1923). During this period of field work, rock and stream-sediment samples were collected by F. G. Lesure for geochemical trace-element analyses, and peat deposits were investigated by C. C. Cameron. Stream sediments were analyzed in the U.S. Geological Survey laboratories, Reston, Va.; rock samples were analysed in the U.S. Geological Survey laboratories, Denver, Colo. Records of test holes for oil and gas exploration in nearby areas and related publications were examined by W. J. Perry, Jr., for an evaluation of the oil and gas potential.

The economic potential of mineral resources in the Dolly Sods Wilderness Area was determined by the U.S. Bureau of Mines following reviews of earlier studies and unpublished records. Field and sampling activities were conducted by J. J. Hill, P. C. Mory, B. B. Williams, and M. L. Dunn, Jr., in September and October 1975. These activities were focused mainly on an evaluation of the coal beds, including examination of six adits within the area and several adits and coal exploratory trenches in nearby areas. Twenty-nine samples of coal, sandstone, and shale were taken for analysis to determine the potential value of these products.

Proximate and ultimate analyses of the coal samples were performed by the U.S. Department of Energy, Division of Solid Fuel Mining and Preparation, Coal Analysis (formerly the U.S. Bureau of Mines Coal Preparation and Analysis Group), Pittsburgh, Pa. Spectrographic, chemical, and atomic-adsorption analyses were performed by the U.S. Bureau of Mines, Reno Metallurgy Research Center, Nev. Shale samples were evaluated for possible ceramic value by the U.S. Bureau of Mines, Tuscaloosa Metallurgy Research Center, Ala.

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[1] Ferguson, J. B. and Co., Engineers, 1912, Report on coal lands of Robert Bridges Estate in Tucker and Randolph Counties, West Virginia: unpub. report in U.S. Forest Service files, Monongahela National Forest, Elkins, W. Va., 6 p.

[2] Marshall, M. M., 1972, The Nature Conservancy Tract Nos. M21 and M21a (Minerals), Potomac Ranger District, Monongahela National Forest, An Appraisal Report: unpub. report in U.S. Forest Service files, Monongahela National Forest, Elkins, W. Va., 11 p.

Information on mineral ownership and the status of oil and gas leases on Federal lands within and adjacent to the Dolly Sods area was obtained from U.S. Forest Service and Bureau of Land Management records. Completion data on nearby gas wells were obtained from the State of West Virginia, Department of Mines, Division of Oil and Gas, Charleston, W. Va.

ACKNOWLEDGMENTS

The West Virginia Geological Survey, Morgantown, W. Va., kindly made available several out-of-print reports, which aided this study. Appreciation is extended to U.S. Forest Service personnel in the Eastern Regional Office, Milwaukee, Wis., who provided maps and tabulations of mineral and surface ownership and to Forest Service personnel in the Area Supervisor's Office, Elkins. W. Va., for the locations of oil and gas leases on Federal lands. Copies of oil and gas leases were obtained from the U.S. Bureau of Land Management in Washington, D.C.

GEOLOGIC APPRAISAL

By K. J. Englund and R. C. Warlow

About 490 m of sedimentary rocks of Late Mississippian to Late Pennsylvanian age crop out in the Dolly Sods Wilderness Area and 7,620–9,144 m of older Paleozoic sedimentary rocks may be present in the subsurface. The basal 213 m of the exposed beds, probably representing intertidal mud-flat deposits, are assigned to the Mauch Chunk Formation of Late Mississippian age. This formation crops out along the lower valley slopes bordering Red Creek and its tributaries in The southwest part of the area (pl. 1). The rest of the exposed stratigraphic section consists of continental coal-bearing rocks of the New River, Kanawha, Allegheny, and Conemaugh Formations of Early to Late Pennsylvanian age. These formations are preserved in the trough of Stony River syncline as an isolated remnant of a sequence that was once laterally continuous with Pennsylvania rocks in the Appalachian Plateaus to the west.

STRATIGRAPHY

MISSISSIPPIAN SYSTEM

MAUCH CHUNK FORMATION

The Mauch Chunk Formation (Lesley, 1876) is characterized by an abundance of grayish-red shale, silty shale, and siltstone interbedded with lesser amounts of similarly colored sandstone and greenish-gray shale. The shale, silty shale, and siltstone range from nonbedded to evenly bedded and slightly calcareous. Sandstone, which makes up about 15 percent of the formation, is very fine to fine grained, grayish red to light greenish gray, and micaceous and has a relatively low quartz content of about 50 percent. It is thin to thick bedded, partly ripple bedded, and mostly nonresistant, but in places it may form ledges and cliffs as much as 6.1 m high. Lenses of subrounded to angular rock fragments in a sandy to argillaceous matrix occur at the base of many thick sandstone beds. About 213 m of the Mauch Chunk Formation is exposed, and possibly another 30.5 m of beds of similar lithology are present in the subsurface above the underlying Greenbrier Limestone, which crops out on the flanks of the Stony River syncline less than 0.8 km beyond the east and west boundaries of the Dolly Sods area. The outcrop belt of the Mauch Chunk Formation, on the lower valley slopes of Red Creek and its tributaries, is largely concealed by detritus from overlying sandstone beds. The formation underlies the rest of the Dolly Sods area at depths of as much as 290 m.

PENNSYLVANIAN SYSTEM

NEW RIVER AND KANAWHA FORMATIONS, UNDIVIDED

A coal-bearing sequence that includes prominent cliff- and ledge-forming sandstone beds makes up the New River and Kanawha Formations, undivided, of Early and Middle Pennsylvanian age, in the Dolly Sods area. In Fayette County, W. Va., the upper contact of the New River Formation (Fontaine, 1874) is placed at the top of the Nuttall Sandstone Member (Campbell, 1902). Because of the isolation of the Dolly Sods area, identification of this sandstone member is doubtful. For this reason and because of the lack of significant lithic differences, the New River and Kanawha Formations are undivided in the report area. Their total thickness ranges from about 168 to 189 m. In ascending order, this unit is composed of conglomeratic sandstone; an interbedded sequence of nonresistant sandstone, siltstone, silty shale, shale, coal, and underclay; and the Roaring Creek Sandstone of White (1903).

The basal sandstone bed is very light gray to white, medium to coarse grained, quartzose, and conglomeratic. It is commonly thick bedded to massive, is conspicuously crossbedded, and forms a cliff or ledge, including a prominent waterfall where it passes below Red Creek about 0.8 km upstream from Stonecoal Run. Conglomerate in the sandstone consists of well-rounded white quartz pebbles that range mostly from 0.01 to 0.03 m in diameter. The sandstone ranges from 0 to 12 m in thickness and appears to be absent only on the south and west edges of the area near South Fork and Gandy Run.

The nonresistant beds between the basal sandstone and the Roaring Creek Sandstone of White (1903) consist of medium-gray to black shale, silty shale, and siltstone; light-gray, very fine to medium-grained micaceous sandstone; clayey to silty underclay containing fossil rootlets; and three coal beds. The most extensive coal bed, 28–46 m above the base of the formation, is tentatively correlated with the widely recognized Sewell coal bed. Two discontinuous, locally mapped coal beds in the overlying sequence are unnamed. This sequence of coal-bearing strata ranges from 107 to 122 m in thickness and crops out extensively along Red Creek and its tributaries. Steep slopes underlain by the unit are largely covered by colluvium derived from White's overlying Roaring Creek Sandstone.

The thickest and most prominent cliff-forming sandstone in the Dolly Sods area is tentatively correlated with the Roaring Creek Sandstone of White (1903). It is of similar lithology and stratigraphic position where it has been mapped in the Roaring Creek area, about 48 km west of the report area (Englund, 1969). This sandstone has also been referred to as the "Homewood Sandstone" (Reger, 1931, p. 240) and as the "Upper Connoquenessing Sandstone" (Reger, 1931, p. 129, 243) in nearby Randolph County. The upper 15–38 m of this sandstone was correlated with the Homewood Sandstone by Reger and others (1923, p. 199) in Tucker County. In the Dolly Sods area the sandstone is white, fine to coarse grained, quartzose, and conglomeratic and contains well-rounded white quartz pebbles ranging mostly from 1 to 3 cm in diameter. The lower and upper thirds of the member are commonly the most massive, cliff forming, and conglomeratic. Intervening beds are less resistant, are thin to thick bedded, and include lenses of shale and siltstone. White's Roaring Creek Sandstone ranges in thickness from about 58 to 67 m and is widely distributed in the Dolly Sods area. It caps ridges bordering Red Creek in the central part and Cabin Mountain and Allegheny Mountain on the west and east edges of the area.

ALLEGHENY FORMATION

The Allegheny Formation of Middle and Late Pennsylvanian age is a coal-bearing sequence consisting largely of sandstone, siltstone, and shale. In the Dolly Sods area it ranges from 58 to 64 m in thickness and consists of (1) a persistent clay bed at its base, (2) a widespread coal zone – tentatively correlated with the Kittanning coal beds – and (3) a mapped sandstone member at its top. Distribution of these units is fairly widespread in the gently sloping upland areas.

The clay bed at the base of the formation consists of as much as 3 m of light- to medium-gray plastic clay that locally includes lenses of flint and semiflint clay. The flint clay is hard, nonplastic, and white to light brownish gray and breaks with a smooth conchoidal fracture. The semiflint is similar in color but is softer and breaks with a rough or irregular fracture. Overlying the basal clay bed is the Kittanning coal zone which consists of one to three coal beds in a maximum interval of nearly 30 m. The strata between the Kittanning coal zone and the mapped sandstone member at the top of the formation consist mainly of medium-gray shale and nonresistant thin- to thick-bedded, fine- to medium-grained micaceous sandstone. Locally, the sandstone beds are moderately resistant and crop out in ledges along the ridge crest.

The mapped sandstone member at the top of the Allegheny Formation caps broad benches in the north-central part of the Dolly Sods area. It ranges from 6 to 9 m in thickness and is light gray to white, fine to coarse grained, and crossbedded. In most places the sandstone is quartzose and contains well-rounded white quartz pebbles that range mostly from 1 to 1.5 cm in diameter.

CONEMAUGH FORMATION

As much as 30 m of shale and sandstone in the lower part of the Conemaugh Formation of Late Pennsylvanian age caps isolated hilltops bordering the north-central margin of the report area. Exposures are highly weathered and iron-oxide stained, but auger samples show traces of grayish-red and greenish-gray shale that are characteristic of the formation. Auger samples also indicated a flint-clay bed of undetermined thickness near the base of the formation. The sandstone is light gray, fine to coarse grained, feldspathic, micaceous, and relatively low in quartz content. Angular to subrounded quartz pebbles as much as 1 cm in diameter are in lenses near the base of the sandstone.

QUATERNARY SYSTEM

Quaternary deposits in the Dolly Sods area consist of alluvium in the flood plain of Red Creek and colluvium and talus accumulations on hill slopes and ridge tops and along the steeper tributaries of Red Creek. This locally derived material is found mostly as subrounded to angular boulders and gravel (fig. 6). An extensive mantle of large angular blocks of conglomeratic sandstone that may have originated from frost action on a parent sandstone bed (figs. 7, 8) is of particular significance on ridge tops and slopes along Allegheny and Cumberland Mountains.

STRUCTURE

The Dolly Sods area is situated in the central part of the Appalachian folded belt. It lies in the broad Stoney River syncline, a southwest-trending extension of the larger Georges Creek syncline. The trough line

FIGURE 6.–Typical view of lower Red Creek showing sandstone boulders and a log bridge.

FIGURE 7.–A “boulder sea” caused by freezing and thawing cycle, near a scenic overlook on Allegheny Mountain.

FIGURE 8.—View southwest along Allegheny Mountain, showing large boulders of conglomeratic sandstone and frost-trimmed conifers.

of the Stoney River syncline strikes irregularly N. 30° E. and also plunges slightly to the northeast. Structure contour lines drawn on top of the Roaring Creek Sandstone of White (1903) show that the rocks dip gently from about 2°–3° near the trough line of the syncline to as much as 7° on the east limb and 20° on the west limb. The west limb is deformed by two subsidiary folds, a shallow syncline and an anticline that trend parallel to the trough of the Stoney River syncline. Strata in the Dolly Sods area were folded during the Appalachian orogeny in late Paleozoic time, and the folding possibly into early Mesozoic time. That initial deformation may have begun as early as the Pennsylvanian Period, as is suggested by slight troughward thickening of Pennsylvanian sediments in the Stoney River syncline.

MINERAL RESOURCES

The principal mineral resource in the Dolly Sods area is bituminous coal. Development has been small scale and has included several shallow adits that provided fuel for steam locomotives during early logging operations. A later development consisted of a small mine with facilities for truck haulage, which may have supplied coal for local household use. Natural gas, peat, shale, flint clay, and high-silica sandstone are mineral resources that may be of potential economic value. Mining or prospecting for metallic resources is unknown in or near the area.

COAL

Coal in the Dolly Sods area is of low- to medium-volatile bituminous rank and is found in at least seven beds in the New River, Kanawha, Allegheny, and Conemaugh Formations. All the coal is banded with dull and bright attritus and with lesser amounts of vitrain and powdery fusain. Partings of impure coal, shale, and underclay are common in most beds, and finely disseminated pyrite is sparse in some beds. The stratigraphic position and range in thickness of each coal bed and the thickness and lithology of rocks between the coal beds is presented in a generalized stratigraphic section (fig. 9).

Coal resources have been estimated (table 1, on pl. 2) for the Sewell(?) and two unnamed coal beds in the New River and Kanawha Formations, undivided, and for the Kittanning coal zone in the Allegheny Formation. The lack of continuity between these coal beds and correlative beds in the Appalachian coal region to the west presents some uncertainty in coal-bed identifications. For this reason, only tentative correlations have been established with the Roaring Creek area (Englund, 1969) on the basis of the stratigraphic position of beds.

The Sewell(?) coal bed is widely distributed along the lower valley slopes of the study area. Resources in the bed are located principally along tributaries of Red Creek in the central part of the area, where measurements made at old adits and outcrops indicate that the coal ranges from 25 to 86 cm in thickness, excluding one to two partings that aggregate as much as 15 cm in thickness. The bed thins toward the margins of the report area and may be absent locally.

Two unnamed coal beds at approximately 30 and 60 m above the Sewell(?) coal bed contain resources locally along the Red Creek above the mouth of Stonecoal Run. These beds attain maximum thickness of 66 and 43 cm, respectively, and may be of limited areal distribution.

Locally one to three coal beds near the base of the Allegheny Formation make up the Kittanning coal zone. Other names–Upper Kittanning and Lower and Upper Freeport–have been applied previously to these coal beds (Reger and others, 1923). Regardless of their correlation, these coal beds are principally in an east-trending belt across the central part of the report area, where they total as much as 2.4 m in thickness. Because of their lenticular character, the combined thickness of coal is used for convenience in coal-resource calculations

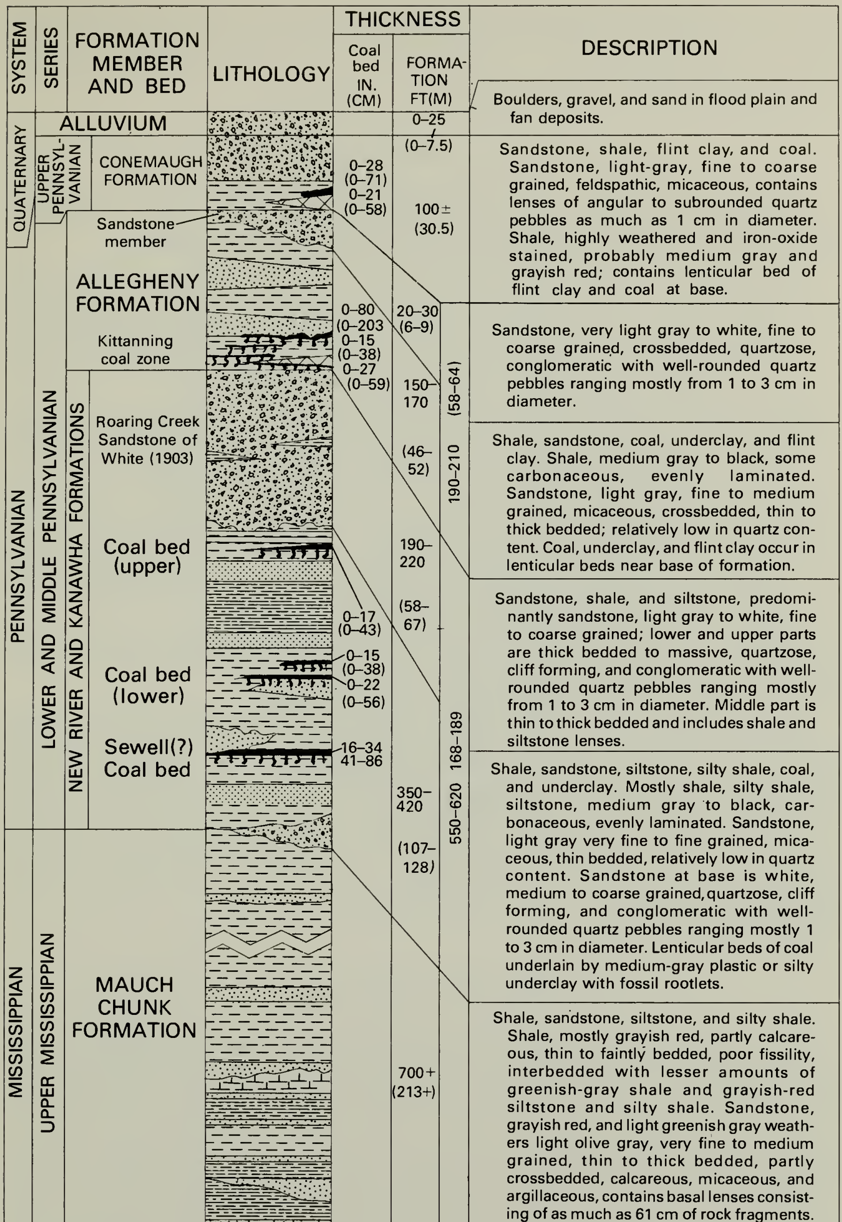


FIGURE 9. – Section exposed in the Dolly Sods Wilderness Area.

where the thickness of each bed is 35 cm or more. Two thin coal beds of undetermined extent were cored earlier in the Conemaugh Formation (Reger and others, 1923, p. 143).

COAL RESOURCES

The coal resources of the Dolly Sods area have been calculated according to standard procedures and categories, as follows:

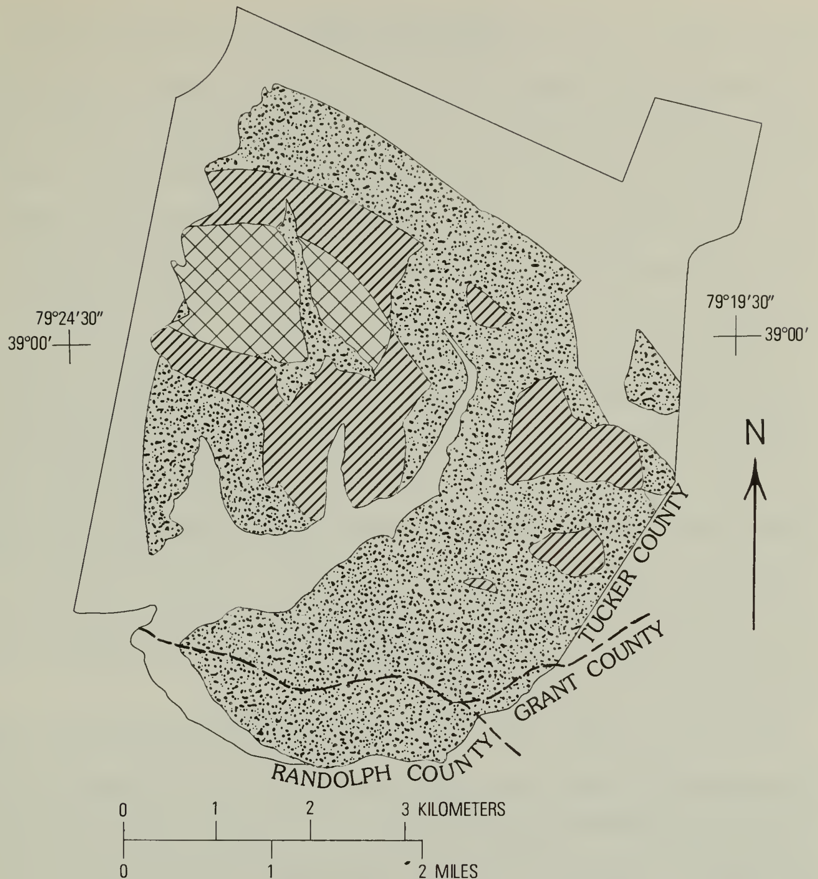
1. Measured resources were computed for areas where the thickness and extent of the coal beds are well defined by measurements 0.8 km or less apart. They generally extend in a belt 0.4-km wide adjacent to an outcrop or points of measurement.
2. Indicated resources were computed where observation points are 0.8–2.4 km apart and for areas that extend in a belt as much as 0.8 km beyond the limit assumed for measured coal.
3. Inferred resources were compiled for areas where observation points are 2.4–9.7 km apart and the continuity of the coal is supported by geologic evidence. Inferred coal extends as a 3.6 km-wide belt 1.2–4.8 km from a measured point.

In addition to these reliability categories, thickness categories of 35–70 cm, 70–105 cm, and >105 cm were used.

The coal beds in the report area contain a total estimated original resource of about 36 million metric tons of low- to medium-volatile bituminous coal (table 1, on pl. 2). Of this total, 66 percent is in the 35–70-cm, or thin, category of thickness, 18 percent is with 70–105-cm, or intermediate, category, and 16 percent is in the >105-cm, or thick, category. Coal resources are mostly in the west-central part of the study area (fig. 10).

FLINT-CLAY RESOURCES

Beds of flint clay and semiflint clay are found locally near the base of the Allegheny and Conemaugh Formations in the Dolly Sods Wilderness Area. Similar clay is found at the base of the Allegheny Formation in the nearby Roaring Creek area of Randolph County. There, the bed is identified as the Mabie clay bed and is suitable for use in medium duty refractories (Englund and Goett, 1968). Because of the lack of fresh exposures, the thickness and extent of the Mabie clay bed at the base of the Allegheny Formation were not determined in the Dolly Sods area, and samples were not obtainable for analysis.



EXPLANATION

Area where coal is absent or less than 35 cm thick

Area underlain by estimated coal resources 35–70 cm thick

Area underlain by estimated coal resources 70–105 cm thick

Area underlain by estimated coal resources greater than 105 cm thick

FIGURE 10.–Known coal-resource distribution of all beds in the Dolly Sods Wilderness Area.

PEAT RESOURCES

By CORNELIA C. CAMERON

Numerous peat deposits have been identified in upland topographic basins along the Allegheny structural front of West Virginia and Maryland. Many of these deposits have commercial potential. The peat is composed of part decomposed plant remains and underlies existing bogs and marshes that contain sphagnum moss, reeds, and sedges. Three types of peat are commonly recognized: That peat composed mainly of moss fibers is termed moss peat; that composed largely of reed and sedge fibers is called reed-sedge peat; and that composed of unidentified plant remains is called humus peat.

Potentially commercial peat must contain less than 25-percent ash on a dry-weight basis. The minimum size of a commercial-peat deposit varies from place to place. In glaciated areas where peat is fairly abundant, such as in Pennsylvania, deposits now being exploited have an areal extent of at least 4 ha and a 1.5 m thickness. In the unglaciated uplands along the Allegheny front near the Dolly Sods area, future development of deposits that have less than a 0.6 m thickness of commercial-quality peat does not seem likely, regardless of areal extent. Tonnage in peat deposits is calculated on the basis of 200 tons of air-dried peat per acre-foot. Currently all peat is being sold for agricultural and horticultural uses.

Peat forms in basins where the rate of accumulation is greater than the rate of plant decay. The climate of the Dolly Sods area favors the accumulation of peat; rain and fog sweeping over the uplands on the Allegheny Plateau help maintain a high humidity and a constantly high water table. These conditions facilitate the growth of moss and other peat-forming vegetation. A peat deposit that is saturated with ground water generally is relatively free from destructive aerobic bacterial activity; but if the ground-water table is lowered, which allows oxygen to enter the deposit, the peat fibers are destroyed and the ash content is increased.

In a study of 30 peat deposits, Cameron (1970) found that peat deposits were situated above easily eroded beds whose trends were controlled by the regional structure. Fourteen of these deposits containing commercial-quality peat in beds at least 0.6 m thick are on terraces, divides, or interfluves within broad valleys that have trenched streams. These valleys are generally in areas of almost horizontal beds near the noses of gently plunging anticlines, in the troughs of synclines, or on monoclines. The depressions filled with peat on these terraces, divides, or interfluves are lined with gray pond that the peat is preserved in a state of saturation.

Large deposits of moss and reed-sedge peat lie in Canaan Valley about 8 km north of the Dolly Sods Wilderness Area. Several of the deposits in Canaan Valley, each having a potential of more than 100,000 t (metric tons) of air-dried peat, are 1–1.5 m thick. Other large deposits are in the Castleman Basin in nearby Garrett County, Md., where humus and reed-sedge peat are being mined and sold in bulk and packaged form at an operation 7 km southeast of Accident, Md.

Bogs dominated by hummocks of sphagnum and polytrichum mosses are common in the Dolly Sods Wilderness Area. However, the structural influence on differential erosion did not favor formation of deep peat-forming basins in which a high water table could be maintained during great fires, such as the Dobbin Slashing Fire, which burned over the area in 1930. The only two peat deposits of note are on horizontal to gently dipping beds of the Allegheny Formation in the northern part of the Wilderness Area (fig. 11). The two deposits have a total potential yield of 28,000 t of sphagnum-moss peat, but as average thickness is only about 30 cm, development at this time does not appear feasible.

GEOCHEMICAL SURVEY

By FRANK G. LESURE

SAMPLING AND ANALYTICAL TECHNIQUES

Reconnaissance geochemical sampling of the Dolly Sods Wilderness Area was done to find indistinct or unexposed mineral deposits that might be recognized by their geochemical halos. No metallic deposits are reported to be in the Wilderness Area, and none were found during field work. The geochemical samples consist of 69 stream-sediment, 14 soil, and 86 rock samples (pl. 3). Most of the small drainage basins within the Wilderness Area and many of those adjacent to it were sampled by collecting a few handfulls of the finest sediment possible. The samples were dried and sieved in the laboratory; the minus 80-mesh (0.177-mm) fraction was used for analyses.

Rock samples collected during geologic mapping are representative of all rock types exposed in the area. The few soil samples are from areas of poor rock exposure.

Stream-sediment samples were analyzed for 64 elements by computerized semiquantitative emission-spectrographic methods and for gold by combined fire-assay and atomic-absorption techniques in the U.S. Geological Survey laboratories in Reston, Va. The rock and soil samples were analyzed for 30 elements by six-step semiquantitative

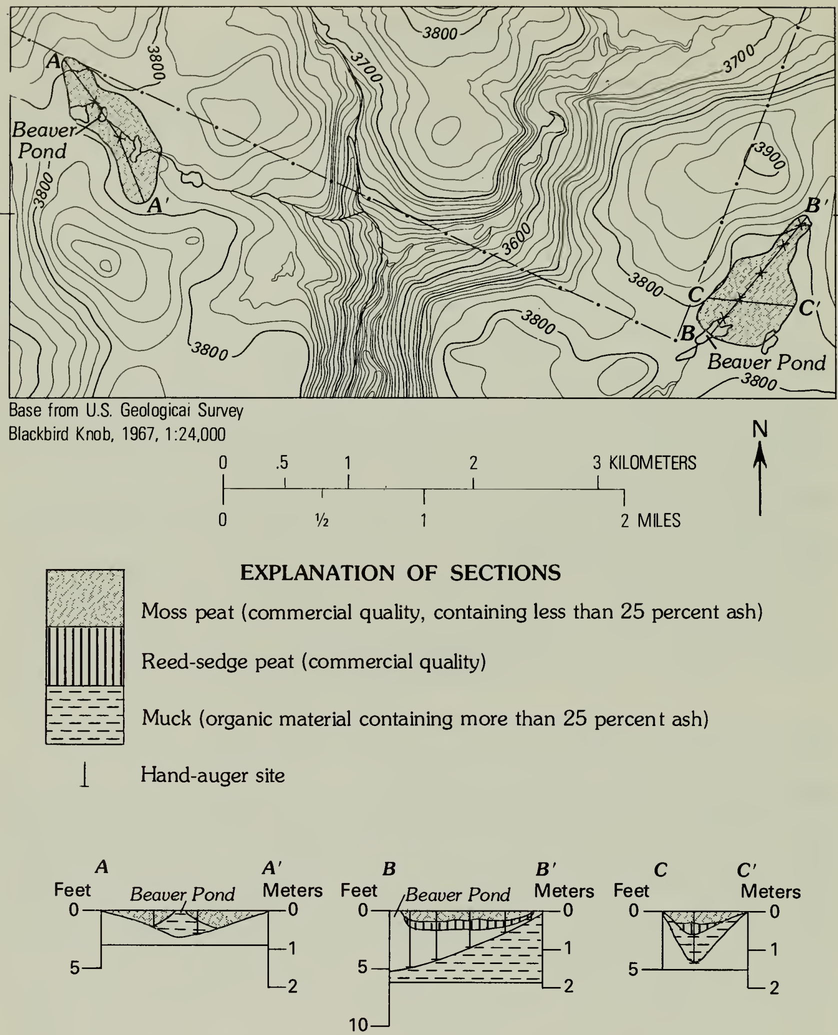


FIGURE 11.–Peat deposits and sections on beds of the Allegheny Formation in the Dolly Sods Wilderness Area.

spectrographic methods and for zinc, by atomic-absorption techniques in the U.S. Geological Survey laboratories in Denver, Colo., and for gold, by combined fire-assay and atomic-absorption techniques in the U.S. Geological Survey laboratories in Reston, Va. The complete analytical data are given in Motooka and others (1978) and are summarized in table 2.

TABLE 2.—*Range and median values for 24 elements in rock, soil, and stream-sediment samples from the Dolly Sods Wilderness Area and vicinity, Grant, Randolph, and Tucker Counties, W. Va.*

[Analyses of rock and soil were done in Geological Survey laboratories, Denver, Colo., by J. M. Motooka using six-step semiquantitative emission spectrographic methods; zinc was analyzed by C. A. Curtis using atomic-absorption methods. Stream sediments were analyzed for 64 elements in Geological Survey laboratories, Reston, Va., by Leung Mei using computerized semiquantitative emission-spectrographic methods. Six-step spectrographic analyses reported to the nearest number in the series 1, 1.5, 2, 3, 5, 7, and 10, which represent approximate midpoints of group data on a geometric scale. The assigned groups for the series will include the quantitative value about 30 percent of the time. Computerized spectrographic data for stream sediments have been converted to this series for comparison. Symbols used: L, detected but below limit of determination (value shown in parenthesis after element symbol); N, not detected. Limit of detection of computerized method where it is different is shown after symbol. Lower limits of determination shown in parentheses after symbol for element. Elements looked for spectrographically in rock and soil but not found and their lower limits of determination: As(200), Au(20), Bi(10), Cd(20), Sb(100), and W(50)]

Elements	Sandstone (41 samples)				Shale (37 samples)				Soil (13 samples)			Stream sediments (69 samples)		
	Low	High	Median	Average[1,2]	Low	High	Median	Average[2]	Low	High	Median	Low	High	Median
Percent														
Ca(0.05)	N	20	L	3.9	N	10	0.1	2.21	N	0.15	L	0.015	0.7	0.07
Fe(0.05)	.07	15	1	.98	.5	15	3	4.72	.2	5	.7	.3	5	2
Mg(0.02)	L	1.5	.2	.7	.03	1.5	1	1.5	L	.2	.08	.02	.7	.2
Ti(0.002)	.02	1.5	.3	.15	.15	1	.5	.46	.2	.7	.5	.15	1	.5
Parts per million														
Ag(0.5)	N	1.5	N	[3]0.0X	N	0.05	N	0.07	N	N	N	L	0.5	L
B(10)	L	70	30	20–30	10	150	70	100	15	50	30	15	150	70
Ba(20)	N	1,500	200	300	100	2,000	500	580	50	200	150	50	700	300
Be(1)	N	5	1	2	L	3	2	3	N	3	L	L	10	3
Co(5)	N	20	5	.3	N	30	15	19	N	L	N	L(1)	50	7
Cr(10)	N	70	20	10–20	10	70	70	90	L	70	50	15	300	50
Cu(5)	N	100	5	10–20	N	500	30	45	N	30	7	L(1)	30	10
La(20)	N	70	N	30	N	100	50	92	N	50	20	15	100	30
Mn(10)	10	5,000	300	500	10	3,000	300	850	20	1,500	60	20	5,000	300
Mo(5)	N	5	N	.2	N	10	N	2.6	N	5	N	L(2)	3	L(2)
Nb(20)	N	L	N	[3].0X	N	30	L	11	N	20	L	L(15)	50	20
Ni(5)	L	30	15	2	5	50	50	68	L	15	7	2	70	15
Pb(10)	N	30	N	9	N	50	15	20	N	30	10	L(7)	30	15
Sc(5)	N	15	7	1	5	15	15	13	L	15	7	2	15	10
Sn(10)	N	N	N	[3].X	N	30	N	6	N	N	N	L(15)	L(15)	L(15)
Sr(100)	N	500	N	20	N	300	100	300	N	100	N	10	150	70
V(10)	N	200	50	10–20	30	150	150	130	15	150	50	20	150	70
Y(10)	N	70	20	40	15	50	30	26	L	50	20	15	70	30
Zn(5)	20	110	50	16	20	160	80	95	20	130	30	L(15)	200	30
Zr(10)	50	700	200	200–250	70	300	150	160	100	700	200	150	>2,000	300

[1] Pettijohn, F.J. (1963, p. S11). [2] Turekian, K.K., and Wedepohl, K.H. (1961). [3] Order of magnitude estimated by Turekian and Wedepohl (1961).

RESULTS

No anomalous values rélated to obviously mineralized rock were found. The sandstone and shale bedrock are about average in trace-element content. The median values of 24 elements for 41 sandstone and 37 shale samples compare closely with the average values for sandstone and shale (table 2) and are similar to results obtained in geochemical surveys of the same geologic section in the New River Gorge from Hinton to Gauley Bridge, W. Va. (Lesure and Whitelow, 1977) and the Cranberry Wilderness Study Area, Pocahontas and Webster Counties, W. Va. (Meissner and others, 1978). Similarly, median values for those same elements in stream sediments agree closely with the median values for stream sediments for the New River Gorge area and the Cranberry Wilderness Study Area.

The one high value of copper in rock, 500 ppm Cu (sample WVD 105; pl. 3) is from a bed of red shale in the Mauch Chunk Formation exposed in the road cut at the southwest edge of the Wilderness Area near Laneville. The red-shale bed and the one just below it (sample WVD 104; pl. 3) also contain silver. The combination of silver and copper is a common metal association in some red-bed sequences (Lesure, Motooka, and Weis, 1977, p. 13). The values found are of interest scientifically but not economically.

Twelve samples (WVD 001, 014, 016, 017, 018, 020, 021, 022, 039, 041, 059, and 071) have much higher (150–200 ppm) than the median (30 ppm) values for zinc in stream sediments (table 2; Matooka and others, 1978); they are mostly outside the study area and are mostly from sample sites near a road (pl. 3). These higher zinc values may be related in part to traces of zinc in the lower part of the exposed stratigraphic section, especially the Mauch Chunk, which appears to contain a little more zinc than the overlying New River and Kanawha Formations.

OIL AND GAS POTENTIAL

By WILLIAM J. PERRY, JR.

The history of oil and gas exploration in the vicinity of the Dolly Sods Wilderness Area is summarized on the accompanying table of wells drilled for natural gas or oil (table 3). Much of this data is extracted from Cardwell (1974), augmented by data from the files of the West Virginia Geological and Economic Survey. On the basis of carbon-ratio measurements from coal samples, Reger (1923, p. 260) considered the rocks of Tucker County "too much metamorphosed [that is, to be of too high a thermal maturity] to have preserved any large content of oil." Subsequent studies, especially the determination and calibration of CAI (the conodont alteration index) by Epstein, Epstein, and Harris (1977), validate this conclusion and show a thermal maturity well within the range for natural gas.

Subsequent to Reger's work, several gas fields have been discovered in Tucker County (fig. 12). The Dolly Sods Wilderness Area is approximately 3.2 km southeast of the Canaan Valley gas field and about 5.6 km east of the one-well Red Creek field; both fields are in fractured and faulted Lower Devonian rocks. In his Tucker County report, Reger (1923) correctly predicted the approximate depth and gas productive (Lower Devonian Oriskany) section in the Canaan Valley field. The Oriskany gas fields of the Dolly Sods region are classified by Haught and McCord (1960) as "eastern Oriskany fields."

As discussed by Haught and McCord (1960):

> The eastern Oriskany fields produce only 'dry' gas, and are located on anticlines in a region of strong folding, accompanied by much fracturing and faulting. In many places, production is bounded downdip by the presence of salt water, but elsewhere lack of sufficient permeability is clearly the bounding factor, since marginal wells are poor producers even after [hydraulic] fracturing, but show no salt water. Production in these fields seems to depend upon [natural] fracture permeability, in contrast to the intergranular permeability clearly characteristic of the western fields.

The probable origin of this fracture permeability and porosity is discussed by Perry (1975) and Perry and de Witt (1977). The structural geometry of many of these eastern fault-bounded Oriskany fields in Pennsylvania, West Virginia, and western Maryland is illustrated by Gwinn (1964).

Although the eastern limits of the Canaan Valley and Red Creek gas fields are not defined by drilling, these fields lie along the crests of surface anticlines, which do not extend into the Dolly Sods Wilderness Area. It appears unlikely, therefore, that the gas reservoirs of these two fields extend under the Dolly Sods Wilderness Area.

Only one well near the Dolly Sods Wilderness Area (Tucker–25; see table 3 and fig. 12) revealed a show of gas in rocks younger than the Oriskany Sandstone (Deerparkian) and overlying chert of Onesquethawan Age. This show of gas was found in Middle Devonian shale about 370–530 m above the Oriskany. The gas-productive Upper Devonian sands of northern West Virginia are barren near the Dolly Sods Wilderness Area. Younger rocks are exposed and thus have no oil and gas potential. In discussing the oil and gas potential of eastern Tucker County, Reger (1923) concluded that "it is doubtful whether any hope of gas could be entertained in the sands above the Oriskany, owing to their extensive outcrops in the Cheat Valley."

A recent major Lower Silurian gas discovery in Centre County, Pa., (the AMOCO-UGI Development, no. 1 Texasgulf; Oil and Gas Journal, 1977, p. 77) has created extensive interest in the Allegheny frontal zone, which extends southward from Pennsylvania across the Dolly Sods Wilderness Area into Virginia. Petroleum-industry interest has been generated by this 37 million cubic feet per day discovery well,

TABLE 3.–*Wells drilled for natural gas (or oil) near the Dolly Sods Wilderness Area (see east half of fig. 12)*

County and permit no.	Operator–leasee and completion date	Elevation (meters)	Total depth (meters)	Lithologic zones or formations: Name	Lithologic zones or formations: Depth (meters)	Remarks (depth in meters)
Pendleton-A; Source: Reger (1923, p. 272).	North Fork Oil & Gas Co.–No. 1, Clara Harper. Completed, 7/1/19?.	570	564	Needmore Shale (Onondaga Limestone) (?).	54– 67	No shows of gas or oil.
				Oriskany Sandstone (?)	67– 72	
				Needmore Shale (Onondaga Limestone) (?).	72– 241	
				Oriskany Sandstone(?)	241– 248	
				do	363– 366	
				Total depth, Shriver Chert (?)	564	
Pendleton-1	Seneca Oil and Gas Co.–No. 1, Neil Harper. Completed, 10/22/52.	696	915	Reedsville Shale	0– 23	No shows of gas or oil.
				Middle Ordovician limestone.	23– 915	
Pendleton-3	Blaho Oil and Gas Co.–No. 1, James Sites. Completed, 4/19/52.	725	2,790?	"Huntersville" Chert (Onondaga Limestone).	1,717–1,790?	Cardwell (1974) questions the formation depths and whether in fact this well reached the Oriskany.
				Oriskany Sandstone	1,790?	
Randolph-159	Eastern Operating–No. 1, E. H. Cooper. Completed, 4/20/73.	668	2,457	Not reported		No details reported. Well plugged.
Tucker-1	Ohio Oil Co.–No. 1, W. Va. Power & Transmission. Completed, 7/3/44.	1,024	2,449	"Huntersville" Chert (Onondaga Limestone).	2,384–2,429	Initial production, 1.5 million cubic feet (MMCF) from Oriskany. Discovery well, Canaan Valley Field.
				Oriskany Sandstone	2,429–2,449 (Total depth)	
Tucker-2	Ohio Oil Co.–No. 1, Kuykendall and others. Completed, 3/25/46.	1,021	2,563	"Benson" Sand	1,173–1,184	Acidized 2/14/46, 2,531 to 2,561 m with 19,231 L (5,000 gal) hydrochloric acid (strength not given). Acidized 2/23/46, with 19,231 L (5,000 gal) HCl from 2,505 to to 2,525 m. Acidized 3/20/46 with 30.8 cu. m (30,769 L) HCl from 2,505 to 2,563 m. Gas from chert, Oriskany and Helderberg, 4.15 MMCF/day.
				Tully Limestone	2,320–2,326	
				Onondaga Limestone (Needmore equivalent shale).	2,471–2,485	
				"Huntersville" Chert and cherty shale.	2,485–2,515	
				Oriskany Sandstone	2,515–2,554	
				Helderberg Group	2,554–2,563 (Total depth)	
Tucker-3	Cumberland and Allegheny–No. 1, W. Va. Power & Transmission Co. Completed, 1/11/49.	1,005	2,646	"Huntersville" Chert (Onondaga Limestone).	2,426–2,455	Initial production, 446 thousand cubic feet (MCF) per day.
				Oriskany Sandstone	2,455–2,484	
Tucker-4	Cumberland and Allegheny–No. 1, Jason Harman. Completed, 9/19/50.	1,007	2,769	Onondaga Limestone ("Huntersville" Chert).	top 2,527	Show of gas in Helderberg.
				Probably faulted in Oriskany Sandstone and Helderberg Group.		

Tucker-25	Cumberland & Allegheny Gas Co.–W. Va. Power & Transmission Co. Completed, 7/15/58.	992	2,563	Onondaga Limestone ("Huntersville" Chert).	2,546–2,507	Slight show of gas in Middle Devonian shales between 1,981 and 2,134 m. Plugged.
				Oriskany Sandstone	2,507–2,563 (Total depth)	
Tucker-33	Felmont Oil Corp.–No. 1, F. M. Billingslea. Completed, 11/22/61.	978	2,634	Hampshire Formation	235– 420	Show of gas at 2,575 m. Plugged.
				Tully Limestone equivalent.	2,363–2,372	
				Onondaga Limestone ("Huntersville" Chert and Needmore Shale).	2,523–2,561	
				Oriskany Sandstone	2,561–2,630	
Tucker-35	United Producers Fund–No. 1, Harr. Completed, 5/13/70.	1,013	2,607	Tully Limestone equivalent.	(top) 2,318	Acidized 2,511–2,607, with 57.7 cu. m HCl (15,000 gal). Initial production 2.48 MMCF per day. Discovery well, Red Creek field.
				Onondaga ("Huntersville" Chert and Needmore) Shale.	2,467–2,501	
				Oriskany Sandstone	2,501–2,576	
				Helderberg Group	2,576–2,607 (Total depth)	
Tucker-41	Traverse Corp.–No. 1 Lakin, W. H. Wolford. Completed, 2/07/74.	1,120	2,673	Tully Limestone equivalent.	(top) 2,430	Gas and salt water at 2,667. Gas estimated at 100 MCF per day. Plugged.
				Onondaga Limestone ("Huntersville" Chert and Needmore Shale).	2,580–2,626	
				Oriskany Sandstone	2,626–2,673 (Total depth)	

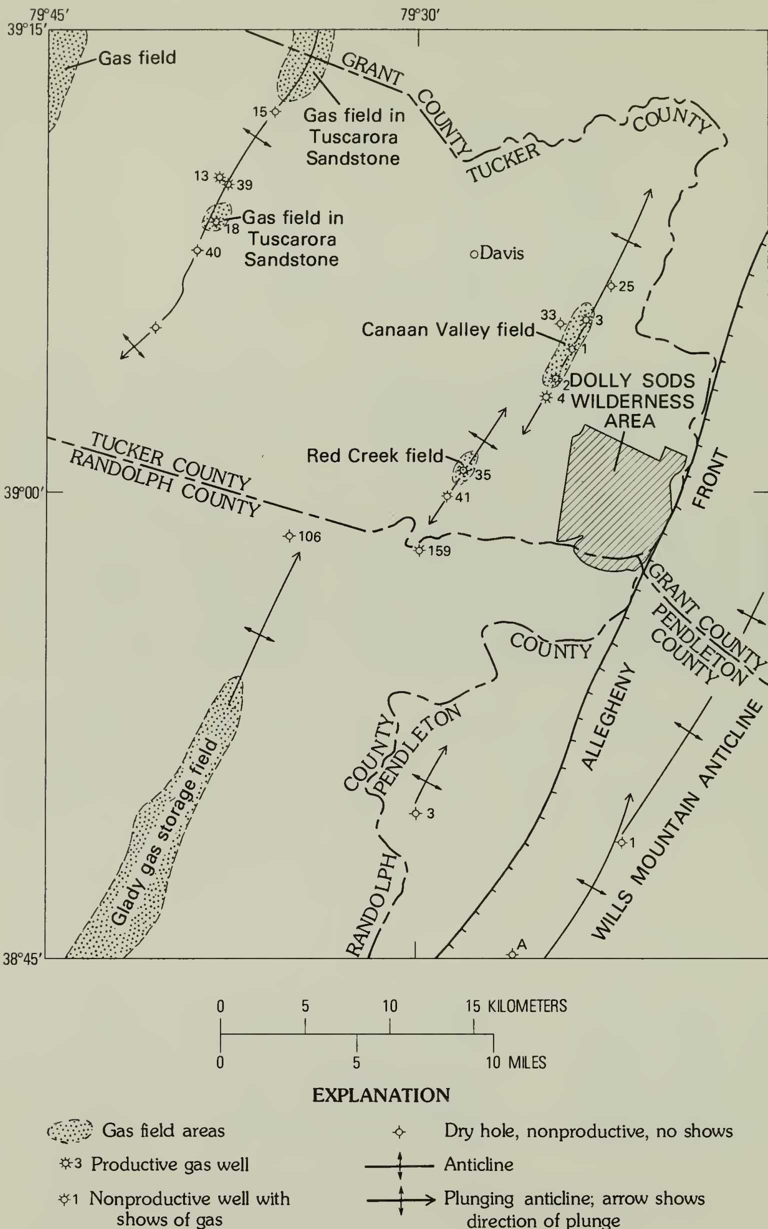


FIGURE 12.–Gas fields and exploratory wells in the region of the Dolly Sods Wilderness Area.

which is relevant to the possibility of gas-bearing fault structures under the Allegheny front. Extensive leasing, symptomatic of this interest, has taken place along the front as far south as Virginia and has led to a second major gas discovery in Mineral County, W. Va., by Columbia Gas Corp. in mid-1979.

The Allegheny structural front is deceptively simple at the surface. There the Upper Devonian through Lower Pennsylvanian strata dip northwestward at a very low angle just west of the steeply dipping to vertical Ordovician through Middle Devonian strata of the western flank of the Nittany anticlinorium to the east (Perry, 1975, 1978). The structural geometry is such that extensive fracturing, faulting, cataclastic or ductile flow, and detachment has taken place in the Middle Devonian and older rocks under the front (fig. 13, from Perry, 1978) several tens of kilometers to the southwest. Low-amplitude folds, such as the anticline mapped in the northern and west-central part of the Dolly Sods Wilerness Area (Englund and Warlow, p. A13) may mark the position of buried thrust-fault traps for natural gas at the Lower Devonian structural level (fig. 2). Such traps under the frontal zone can only be firmly delineated by modern multichannel seismic-reflection methods and drilling. Such data are lacking along the front near the Dolly Sods Wilderness Area, and, therefore, it is speculation to assume that similar structural traps for natural gas may be present.

Qualitatively, the potential for oil does not exist under the Dolly Sods Wilderness Area. However, the potential for natural gas may be rated as fair to good. No meaningful quantitative estimates of undiscovered recoverable natural-gas resources under the Allegheny frontal zone can be made at this time, although the zone is the latest frontier in Appalachian natural-gas exploration.

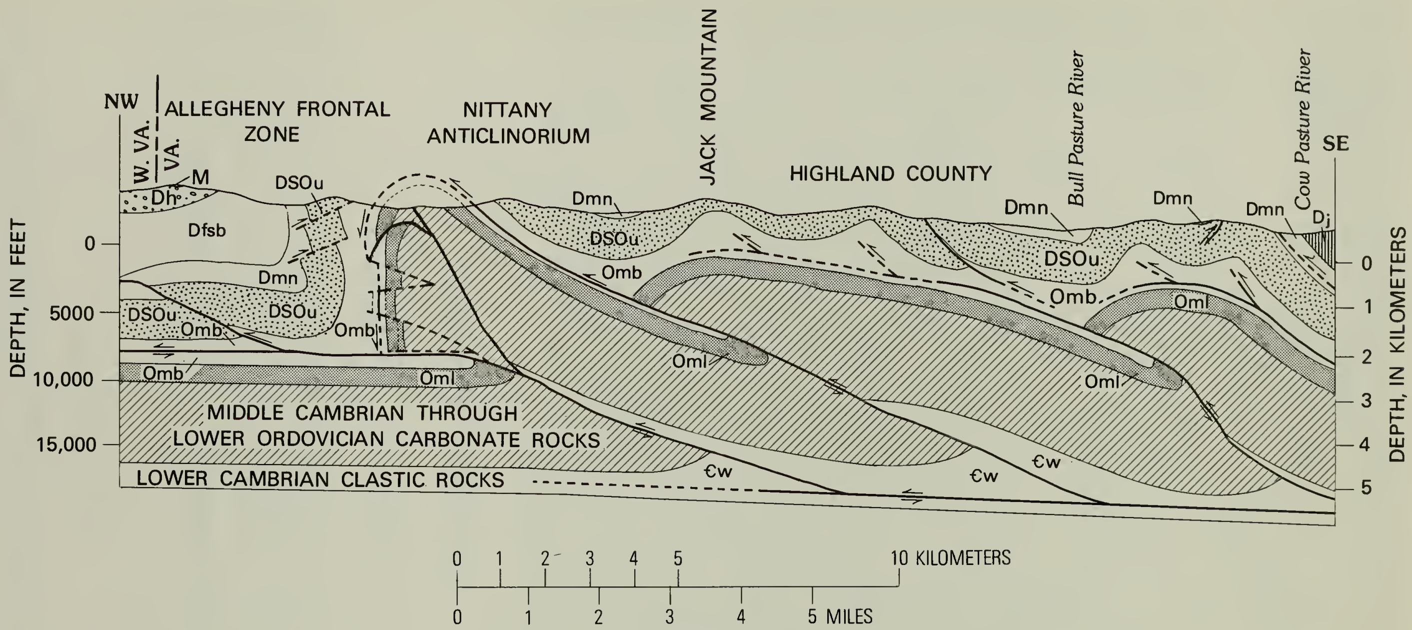
ECONOMIC APPRAISAL

By JAMES J. HILL, PETER C. MORY, BRADFORD B. WILLIAMS, and MAYNARD L. DUNN, JR.

Published information led to an early decision to concentrate this appraisal on coal as the mineral resource most likely to be of economic value in the Dolly Sods Wilderness Area. Attention was also directed toward various sandstone and shale units in order to evaluate their mineral and hydrocarbon potential. The locations of samples collected during this investigation and of several adits and drill holes are shown in plate 3.

FUEL RESOURCES

Two sources of energy in the region are coal and natural gas. Coal is mined northeast of the Dolly Sods area, and natural gas is produced to the west.



EXPLANATION

M—Mississippian rocks
Dh—Hampshire Formation (Devonian)
Dfsb—Foreknobs and Scherr Formations Brallier Shale and (Devonian)
Dj—Jennings Formation (Devonian)
Dmn—Needmore and Millboro Shales (Devonian)
DSOu—Upper Ordovician through Lower Devonian rocks. undivided
Omb—Martinsburg (in part Reedsville) Shale (Ordovician)
Oml—Middle Ordovician limestones
€w—Waynesboro Formation (Cambrian)

FIGURE 13.—Cross-sectional model of the Allegheny frontal zone and Nittany anticlinorium in Augusta and Highland Counties, Va., 65 km southwest of the Dolly Sods Wilderness Area.

COAL

Coal is currently being mined on Pendleton Run near Blackwater Falls State Park, about 13 km northeast of the Dolly Sods Wilderness Area. Several small coal openings and prospects are located in or near the area. Many have been briefly described in West Virginia Geological Survey county reports (Tucker County, Reger and others, 1923; and Randolph County, Reger, 1931). Data concerning the operator, extent of mining, and coal production are generally lacking.

During this investigation, coal thickness and quality could not be determined for many adits whose portals are caved and inaccessible.

Coal beds observed in the field are erratic in nature. In outcrop they thicken and thin in very short distances, as do shale and bone partings in the coal beds. Because of this, presently reported observations may differ from previously published descriptions. Also, present observations are probably not at the precise locations on the outcrop as those described by other investigators.

When sampling coal beds at an outcrop or in adits, an attempt was made to penetrate the face of the coal at least 30 cm in order to reduce effects of weathering on coal quality determinations. A channel sample was cut in this exposed less-weathered part of the bed. In some places, a deep-channel sample could not be taken because the coal was faced back by erosion at the outcrop. Several coal beds had shale or bony coal partings that were not sampled, as such partings would be separated from mined coal before utilization. Coal-bed thicknesses given in the following sections of this report do not include the deleted partings.

Analyses of coal sampled during this investigation are reported in table 4. Published analyses are available for several coal prospects in the area, some of which could not be sampled because of inaccessibility. These analyses are tabulated in table 5 as an aid in evaluating the quality of coal and for comparison with samples taken during this investigation.

Coal-reserve estimates have been prepared using U.S. Geological Survey coal-resource maps as a base. Maps of the reserve base show coal data points and outcrop trace and are for coal beds 70 cm or more thick in the measured and indicated (demonstrated) reliability categories (figs. 14 and 15).

When estimating reserves, we assumed that coal in the area weighed 1,633 t per acre foot. We also assumed that past production had been negligible and that recovery would be 50 percent.

SEWELL(?) COAL BED IN NEW RIVER FORMATION

Ashley (1920, p. 94) mentioned a coal bed on Little Stonecoal Run that had been mined for blacksmithing. He reported that the coal was about 60 cm thick and commonly solid but locally had an 8–10 cm shale parting 10 cm below the top. Reger described a section of this coal in the Tucker County report (Reger and others, 1923) and sampled the coal at outcrop (table 5, sample 124).

During the present investigation, we did not find evidence of mining as described by Ashley. We located the coal by cutting a channel through a shale talus slope at the approximate elevation of 994 m given by Reger (sec. 1, table 6 (sample 227)).

Traces of the adit were probably obliterated long ago by shale talus above the coal bed. Apparently, the adit was not visible in 1919, when Reger conducted his field work, because his sample was taken from the outcrop.

Prior to 1919, an adit was driven on the west edge of Stonecoal Run at an approximate elevation of 945 m. The adit, which has an average height of 1.2 m and width of 1.8 m, penetrated the Sewell for 5.8 m on a bearing of S. 80° W. A channel sample (sample 214, table 4) was cut on the north rib of the adit, midway to the face (section 2, table 6). This same coal is exposed about 30 m upstream of the adit on the east edge of the creek (sample 215, table 4). These analyses corroborate Reger's analysis of the coal in the adit (sample 135, table 5).

Another adit penetrated the Sewell on the south edge of the Wilderness Area, just inside the boundary and north of Forest Service Road 19. The portal of the adit is about 12 m from the edge of the road at an elevation of 1,049 m. As reported by Reger (1931, p. 645), this opening was made by Mr. Elmer White under a lease from the Bridges Estate to supply coal for domestic use. Reger sampled (sample 381, table 5) and described the face (section 3, table 6), 20 m from the entrance.

Presently, the adit is an open, water-filled room. No attempt was made to enter. Sample 223 was taken from the west rib at the portal and consisted of 25 cm of coal and 5 cm of bony coal; the east rib consisted of 48 cm of highly weathered coal. The measurements of coal thicknesses when compared with measurements taken by Reger indicate erratic thickening and thinning.

Sewell(?) coal was sampled (sample 209, table 4) at another exposure on the east side of Red Creek at an approximate elevation of 952 m (sec. 4, table 6).

Thickness of the Sewell(?) coal bed observed in the field, ranges from 25 to 86 cm. The area of demonstrated reserve base for the Sewell coal determined on the basis of thickness and distribution of points of

TABLE 4.—*Coal analyses, in percent*

[Analyses by Department of Energy, Division of Solid Fuel Mining and Preparation, Coal Analysis (formerly U.S. Bureau of Mines, Coal Preparation and Analysis Group), Pittsburgh, Pa. All samples are weathered coal. An attempt was made to penetrate the coal bed at least 30 cm to lessen the effects of weathering on analytical results.]

Sample[1]	Specific gravity	Ash-softening temperature (F°)	Free swelling index	Sample interval (centimeters)	Condition of sample[2]	Proximate analysis: Moisture	Proximate analysis: Volatile matter	Proximate analysis: Fixed carbon	Proximate analysis: Ash	Ultimate analysis: Hydrogen	Ultimate analysis: Carbon	Ultimate analysis: Nitrogen	Ultimate analysis: Oxygen	Ultimate analysis: Sulfur	Calorific value (Btu/lb)
201-K	1.50	2,040	9	22.9	AR	3.0	22.0	58.1	16.9	4.2	67.9	1.1	3.8	6.1	12,260
					MF	----	22.7	59.8	17.5	4.0	70.0	1.1	1.1	6.3	12,630
					MAF	----	27.5	72.5	----	4.9	84.8	1.4	1.3	7.6	15,310
203-U	1.42	2,910+	8	35.6	AR	5.7	18.2	63.5	12.6	4.5	73.6	1.1	7.1	1.1	12,730
					MF	----	19.3	67.3	13.4	4.1	78.0	1.1	2.2	1.2	13,490
					MAF	----	22.3	77.7	----	4.7	90.0	1.3	2.6	1.4	15,570
206	1.45	2,140	4	17.8	AR	9.4	17.7	60.6	12.3	4.7	69.1	1.1	11.2	1.6	11,950
					MF	----	19.5	67.0	13.5	4.0	76.2	1.2	3.3	1.8	13,190
					MAF	----	22.6	77.4	----	4.7	88.1	1.4	3.8	2.0	15,250
207-L	1.44	2,460	7.5	66	AR	8.0	15.3	63.3	13.4	4.5	70.3	1.0	8.6	2.2	12,100
					MF	----	16.6	68.8	14.6	3.9	76.4	1.1	1.6	2.4	13,150
					MAF	----	19.4	80.6	----	4.6	89.4	1.3	1.9	2.8	15,390
209-S	1.53	2,680	6.5	40.6	AR	3.4	17.0	51.1	28.5	3.5	60.0	.9	5.9	.9	10,380
					MF	----	17.6	52.9	29.5	3.5	62.1	.9	3.1	.9	10,750
					MAF	----	25.0	75.0	----	5.0	88.2	1.3	4.2	1.3	15,260
213-L	1.45	2,130	7	45.7	AR	6.4	15.6	62.5	15.5	4.3	68.7	1.0	6.7	3.8	11,960
					MF	----	16.7	66.8	16.5	3.9	73.3	1.1	1.2	4.0	12,770
					MAF	----	20.0	80.0	----	4.6	87.8	1.3	1.5	4.8	15,300
214-S	1.82	2,910+	1	86.4	AR	2.8	14.2	34.4	48.6	2.9	40.2	.6	7.3	.4	6,840
					MF	----	14.6	35.4	50.0	2.6	41.4	.6	5.0	.4	7,040
					MAF	----	29.2	70.8	----	5.2	82.9	1.2	9.9	.8	14,080
215-S	1.25	2,910+	1.5	86.4	AR	7.7	17.5	40.9	33.9	2.8	50.1	.7	11.9	.6	8,590
					MF	----	19.0	44.3	36.7	2.1	54.3	.8	5.4	.7	9,310
					MAF	----	30.0	70.0	----	3.4	85.7	1.2	8.7	1.0	14,710
220	1.43	2,350	8	38.1	AR	6.3	18.4	63.7	11.6	4.6	73.2	1.0	7.1	2.5	12,740
					MF	----	19.6	68.0	12.4	4.2	78.1	1.2	1.4	2.7	13,600
					MAF	----	22.4	77.6	----	4.8	89.1	1.3	1.8	3.0	15,530
221	1.41	2,260	9	25.4	AR	2.4	20.0	66.1	11.5	4.3	75.2	1.1	3.6	4.3	13,390
					MF	----	20.5	67.7	11.8	4.1	77.0	1.1	1.6	4.4	13,720
					MAF	----	23.2	76.8	----	4.7	87.3	1.3	1.7	5.0	15,550
223-S	1.49	2,910+	.5	30.5	AR	9.6	19.4	58.2	12.8	4.5	66.2	1.1	14.9	.5	11,210
					MF	----	21.4	64.5	14.1	3.8	73.3	1.2	7.0	.6	12,400
					MAF	----	25.0	75.0	----	4.4	85.3	1.4	8.2	.7	14,440
227-S	1.37	2,910	8	43.2	AR	4.8	16.6	69.2	9.4	4.5	77.7	1.2	6.4	.8	13,410
					MF	----	17.5	72.6	9.9	4.2	81.5	1.2	2.4	.8	14,080
					MAF	----	19.4	80.6	----	4.6	90.5	1.4	2.6	.9	15,630

[1] Letters after sample numbers indicate coal horizon: Sewell, S; unnamed lower, L; unnamed upper, U; Kittanning, K. Uncorrelated coals have no identifying letter.

[2] AR, As received; MF, Moisture free; MAF, Moisture and ash free.

TABLE 5.–*Coal analyses reported by others*

[Analyses reported by Reger and others, 1923 and Reger, 1931. Samples as received. Analyses reported in percent. Leaders, not reported.]

Sample[1]	Proximate analysis				Ultimate analysis					Calorific value (Btu/lb)	Phosphorous
	Moisture	Volatile matter	Fixed carbon	Ash	Hydrogen	Carbon	Nitrogen	Oxygen	Sulfur		
67–K	1.78	21.31	56.93	19.98	3.85	67.76	1.23	5.70	1.48	12,100	0.050
124–S	1.05	19.07	73.09	6.79	----	----	----	----	.60	----	.022
125–L	.82	18.20	66.83	14.15	----	----	----	----	2.79	----	.012
135–S	.90	18.08	39.97	41.05	----	----	----	----	.37	----	.029
381–S	.39	17.05	62.90	19.66	----	----	----	----	.98	12,425	----

[1] Sample numbers as used by Reger. Letters after sample numbers indicate coal horizon: Sewell, S; unnamed lower, L; Kittanning, K.

TABLE 6.—*Sewell(?) coal-bed sections*

	Thickness	
	Meters	Centimeters
Section 1		
Shale	4.6–5.5	---
Coal	---	10
Shale	---	8
Coal	---	8
Shale	---	8
Coal	---	25
Shale	>1	---
Total coal sampled (sample 227, table 4)	---	43
Section 2		
Sandstone	>1	---
Coal	---	10
Shale	---	13
Coal, bony	---	76
Shale	---	20
Water	---	---
Total coal sampled (sample 214, table 4)	---	86
Section 3		
Sandstone	>1	---
Coal	---	65
Coal, bony	---	[1]15
Shale, visible	---	90
Total coal sampled (sample 381, table 5)	---	65
Section 4		
Sandstone	2.4	---
Shale	---	65
Bony shale	---	1
Coal	---	20
Coal, bony in parts	---	20
Shale	---	---
Total coal sampled (sample 209, table 4)	---	41

[1] Only sampled coal is included in total.

measurement is shown in figure 14. Reserves of Sewell(?) coal are estimated to be 800,000 t (metric tons) on the basis of a coal thickness of 76 cm. Of this total, 240,000 t are measured and 560,000 t are indicated.

Analyses (table 4) of five samples of Sewell(?) coal collected at four localities in the study area indicate that the coal can be tentatively

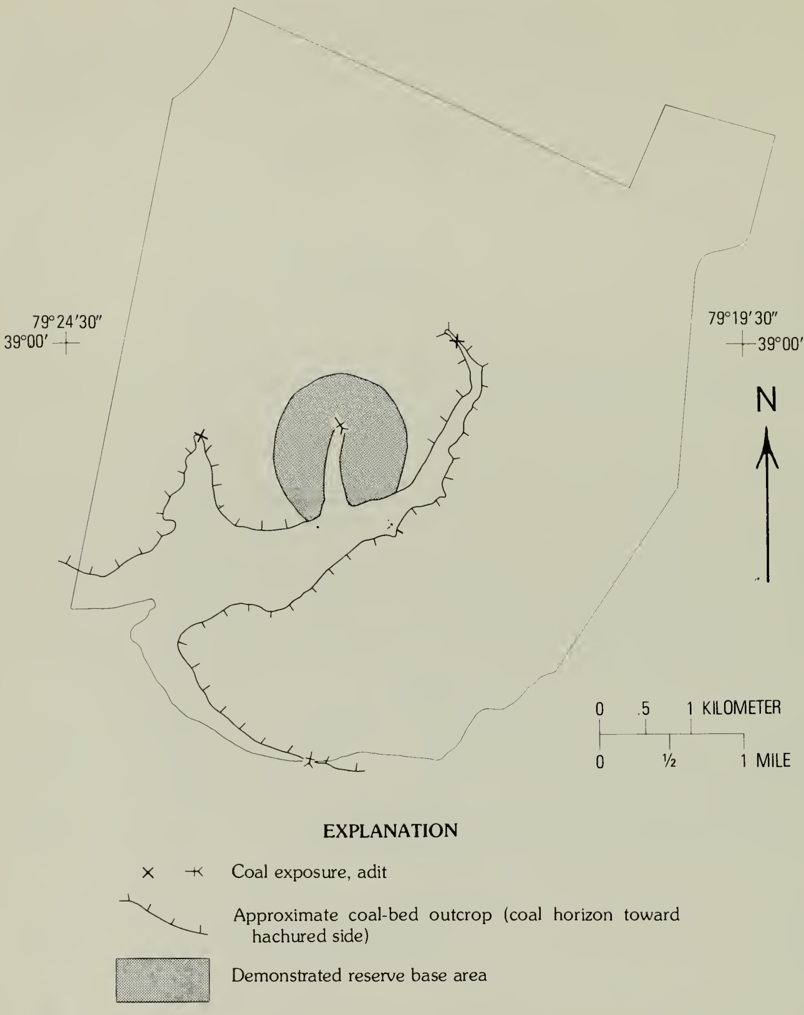


FIGURE 14.–Area of demonstrated reserve base for the Sewell(?) coal bed.

ranked as low- to medium-volatile bituminous. This ranking is tentative because according to ASTM standards, analyses of samples from outcrops or from weathered or oxidized coal should not be used for classification by rank. The analyses also indicate that the coal, as received (AR), has a relatively low sulfur content, ranging from 0.4 to 0.9 percent and averaging 0.6 percent.

One factor adversely affecting quality of the coal is high-ash content. On the basis of analyses of five samples taken during this investigation (table 4) and of three analyses reported by Reger (table 5), ash content (AR) for the Sewell(?) coal ranges from about 6.8 to 48.6 percent and averages 25.1 percent.

UNNAMED COAL BED (LOWER)

An exposure of the unnamed lower coal bed in New River and Kanawha Formations, undivided, (section 1, table 7) was found on Stonecoal Run at an approximate elevation of 983 m. Analysis of this coal (sample 213) is reported in table 4. Reger also sampled the coal (sample 125, table 5) at this locality when preparing the Tucker County report (Reger and others, 1923).

Three coals (section 2, table 7) are exposed along the east edge of Red Creek at an approximate elevation of 970 m.

TABLE 7.—*Unnamed coal-bed sections*

	Thickness	
	Meters	Centimeters
LOWER **Section 1**		
Shale	4.9	---
Coal	---	46
Mudstone	---	10
Water	---	---
Total coal sampled (sample 213, table 4)	---	46
Section 2		
Shale	2.9	---
Coal (sample 206, table 4)	---	18
Shale	3.7	---
Coal	---	0–38
Shale	3.0	---
Coal (see section 3 below)	---	66
Shale	---	---
Total coal sampled (sample 206, table 4)	---	18
Section 3		
Coal, soft	---	23
Bone coal	---	10
Coal	---	33
Total coal sampled (sample 207, table 4)	---	66
UPPER **Section 4**		
Sandstone ledge	0.6	---
Shale	2.1	---
Coal	---	23
Coal, bony	---	13
Shale	---	---
Total coal sampled (sample 203, table 4)	---	36

The upper 18-cm coal is exposed for an approximate distance of 76 m in the cliff at the creek bank. Analysis of this coal (sample 206) is reported in table 4. The middle coal appears to be an erratic lens about 38 cm thick that rapidly grades to shale in a southerly direction. To the north, under the bed of Red Creek, the coal appears to continue for about 9 m, as evidenced by slumping of a sandy overlying unit. Because of its erratic nature, this coal was not sampled. The lower coal (fig. 15)

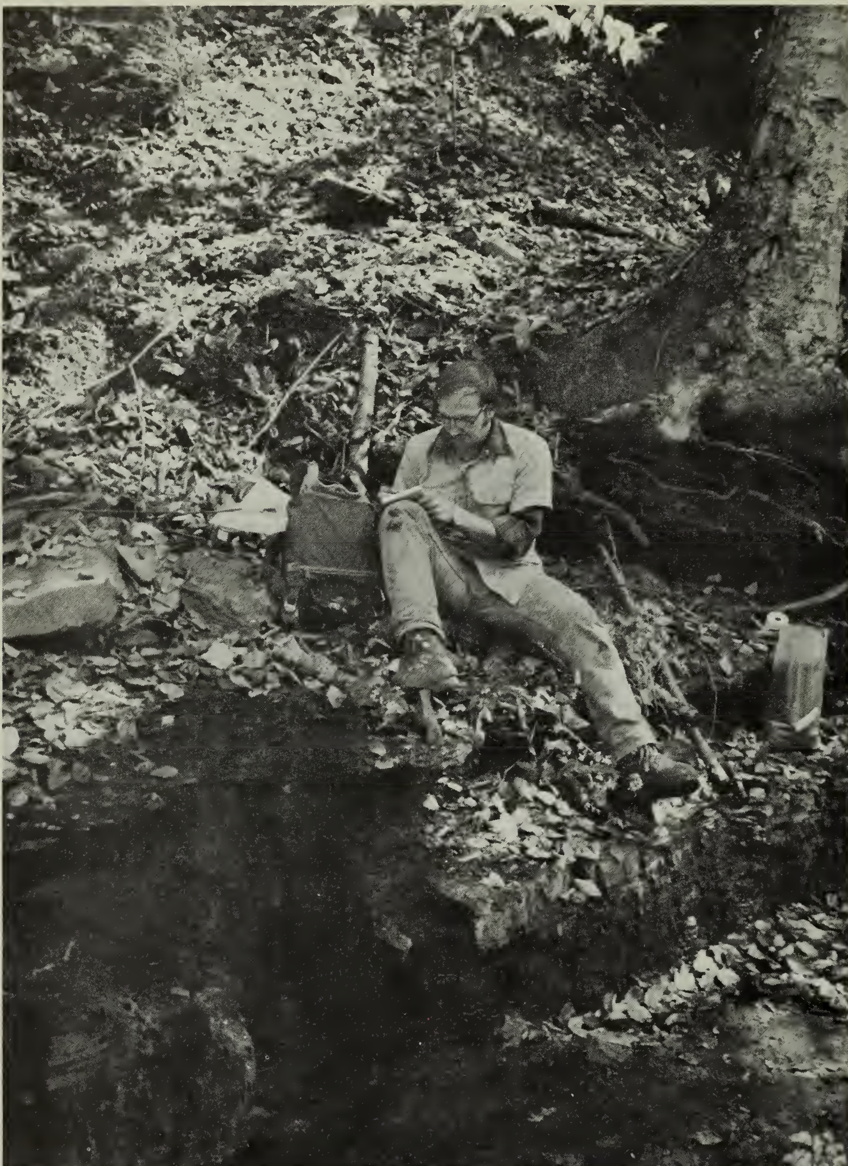


FIGURE 15.–Unnamed lower coal bed on east side of Red Creek.

is exposed (section 3, table 7) for a distance of approximately 30 m. Analysis of this coal (sample 207) is reported in table 4.

Reserves have not been estimated for the coal bed because data on extent and thickness are lacking and because, where observed, the coal thickness was less than 70 cm. Although the coal can only be tentatively ranked, analyses indicate it would be low-volatile bituminous. Sulfur content (AR) ranged from 2.2 to 3.8 percent, and ash content (AR) ranged from 13.4 to 15.5 percent.

UNNAMED COAL BED (UPPER)

Traces of a small adit in an unnamed coal bed (upper) in New River and Kanawha Formations, undivided, are located along the old logging railroad grade, which now serves as the Forest Service Rocky Point Trail 554. The adit is located west of Red Creek at an elevation of about 1,040 m. The trench in front of the adit (directly off the trail) is approximately 18 m long and has a bearing of N. 62° W.

The only rock visible at the head of the trench is a massive sandstone, which probably forms the roof of the portal now covered with slumped debris. A few chips of coal and black shale are visible in the center of the trail in front of the trench.

Records of who made the opening or the quality and thickness of coal are unknown, but the proximity of the opening to the old railroad grade would suggest that it was made during the period of early logging in the area and that the coal was perhaps used by the logging locomotives.

An exposure (section 4, table 7) of this coal bed was sampled (sample 203, table 4) beneath the largest waterfall on Red Creek at an elevation of about 1,015 m. A massive sandstone ledge at the crest of the falls is underlain by shale and coal which have been eroded back 3–4.6 m by the falling water (fig. 16).

Reserves have not been estimated for this coal bed because data on extent were lacking and because the thickness was less than 70 cm where exposed. On the basis of one analysis (sample 203, table 4) the coal is tentatively ranked as medium-volatile bituminous. Sulfur content (AR) is 1.1 percent, and ash content (AR) is 12.6 percent.

KITTANNING COAL ZONE

Several adits in the Kittanning coal zone were found in the study area. On the west side of Stonecoal Run, Reger, Price, and Tucker (1923) mention an adit at an elevation of 1,116 m that had been opened by the Whitmer Land and Lumber Co. for locomotive fuel during their lumbering operations.

The portal was caved in 1919 (Reger and others, 1923), and the adit is

FIGURE 16.–Unnamed upper coal bed beneath a falls on Red Creek.

still flowing mine water. The coal is no longer visible because of slumped debris. In front of the adit is a trench 34 m long that has a bearing of N. 57° E. The trench is about 6 m wide and near the caved portal is about 6 m deep. Spoil banks of black shale and bone coal are on both sides of the trench, and an old railroad grade is barely discernible nearby.

An analysis of a sample collected by Reger of the units described as soft coal (section 1, table 8) is listed in table 5 as sample 67. The sample was taken at the mine mouth.

TABLE 8.–*Kittanning coal-zone sections*

	Thickness	
	Meters	Centimeters
Section 1		
Shale	---	---
Coal, soft	---	53
Shale, gray	---	41
Coal, cannel bone	---	[1]56
Shale, gray	---	25

See footnote at end of table

TABLE 8.–*Kittanning coal-zone sections*–Continued

	Thickness	
	Meters	Centimeters
Section 1—Continued		
Coal, soft	---	38
Coal, bony	---	[1]10
Coal, soft	---	25
Shale, pavement	---	---
Total coal sampled (sample 67, table 5)	---	116
Section 2		
Coal	---	8
Shale	---	13
Coal	---	112
Shale	---	25
Coal	---	94
Total coal	---	214
Section 3		
Sandstone, shale, weathered yellow	---	---
Coal, soft, decomposed	---	36
Coal, yellow shale, clay streaks	---	13
Coal, bony	---	15
Clay, yellow	---	5
Clay, gray, plastic	---	20
Total coal	---	64

[1] Bone coal is not sampled and therefore is not included in total.

An unpublished report in Forest Service files (see footnote 1) indicates that the adit was driven about 27 m into the bed. The report also states that five core holes were drilled in this part of the Dolly Sods Wilderness Area by Mr. F. W. Bridges in 1908. Records of four of these coal tests were provided to Reger by the heirs of Robert Bridges and are published in the Tucker County report (Reger and others, 1923).

The test nearest the adit (drill hole no. 81, Tucker County report (Reger and others, 1923)) shows that sandstone and a 10-cm shale overlie the coal zone and shale and clay underlie it. The section (section 2, table 8) most likely correlates with the section described by Reger at the mine mouth. In the drill log, two coal beds occur below this coal and are interpreted as being in the Kittanning zone. Thirty-eight centimeters of coal that has a 5-cm shale parting is present about 8 m below the upper coal, and about 20 m below this is another coal 61 cm thick overlain by 15 cm of slaty coal.

The coal zone thins in a northerly direction with 58 cm of coal in drill hole no. 82, and 43 cm of coal reported in drill hole no. 83. The northeastern drill hole (drill hole no. 84) did not reach this coal zone but penetrated two uncorrelated coal beds in the Conemaugh Formation.

A thin exposure of Kittanning coal was also found on the upper reaches of Red Creek at an approximate elevation of 1,079 m. Exposed in the west bank of the creek, 20–25 cm of coal overlain by shaly sandstone dips under the creekbed. An analysis of this coal is reported in table 4 as sample 201.

Evidence of coal mining and prospecting in the Kittanning zone is found near the eastern boundary of the Dolly Sods Wilderness Area. An abandoned coal tipple is located west of Forest Service Road 75, downgrade towards Red Creek drainage. The workings consist of two open-cut trenches in front of two adits whose portals are now caved (fig. 17). Records of who made the openings and the amount of coal extracted are not known.

An unsuccessful attempt was made to open the adit at the end of the larger trench for the purpose of sampling and measuring the thickness of the coal. An opening was made that revealed about 20 cm of shale overlain by sandstone. A few stulls were visible above ponded mine water that nearly reached the roof. The southernmost adit was also inaccessible because of slumped debris and cribbing at the portal.

A cut was made in the south rib of the smaller of the two trenches to determine the coal thickness. The material was extremely weathered and decomposed (section 3, table 8).

Another adit in the Kittanning coal zone near the eastern boundary of the Wilderness Area is approximately 1.6 km north of the previously described workings. Access is along Forest Service Wildlife Trail 560 and up a small drainage that crosses the trail.

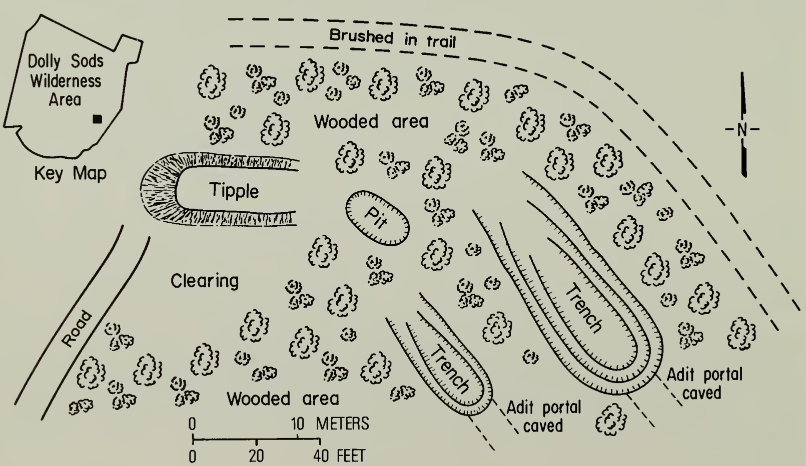


FIGURE 17.–Coal workings in the eastern part of the Dolly Sods Wilderness Area.

The portal of this adit, like most of the others investigated in the area, is now filled with slumped debris. A small opening made near the top of the portal revealed the adit to be about 2.4 m wide, 3 m long, bearing S. 70° W. The heading appeared to descend away from the portal and impounded water reached the roof. The roof rock was shale overlain by sandstone. Near the adit is the trace of a narrow prospect trench. It is not known who made these openings nor the thickness or quality of the coal.

Individual coal beds within the Kittanning zone range from 23 to 213 cm in thickness. The area of the demonstrated reserve base for the upper coal in this zone has been determined on the basis of thickness and location and is shown in figure 18. This is the only area where reserves can be estimated because of the uncertain correlation of beds within the coal zone. Coal thickness reported in the literature is used to estimate reserves because no exposures of thick coal were found in the area during field investigation. Reserves are estimated to be 3.9 million metric tons on the basis of an average coal thickness of 152 cm. Of this total, 0.4 million metric tons are estimated as measured, and 3.5 million metric tons are estimated as indicated. This may be an optimistic estimate because of the abrupt thickening and thinning of coals in the area.

On the basis of this study's one analysis (sample 201) and Reger's analysis (sample 67), the coal is tentatively ranked as medium-volatile bituminous. Sulfur content (AR) ranges from 1.48 to 6.1 percent, and ash content (AR) ranges from 16.9 to 19.98 percent.

UNCORRELATED COAL BEDS

Below the Kittanning coal zone, in the eastern part of the study area, two uncorrelated coal beds are exposed on the first major drainage entering Red Creek from the east, south of Fisher Spring Run. Sample 220 (pl. 3 and table 4) was taken of coal exposed at an elevation of about 1,003 m, and it represents 38 cm of coal resting on shale and overlain by sandstone. Sample 221 (pl. 3 and table 4) is of coal exposed at an elevation of 1,036 m, and it represents 25 cm of coal within sandstone. Both beds are erratic and thin abruptly within short distances; they may be correlative with the lower and upper unnamed coal beds.

In drill hole no. 84 (Reger and others, 1923, p. 143), two uncorrelated coal beds were reported above the Kittanning coal zone. One, 53 cm thick, is 55 m above the Kittanning Zone, and another, 71 cm thick, is about 2.7 m above the first. Reserves have not been estimated for these coals.

The areal extent and quality of these coal beds are unknown and will have to be better defined before a resource evaluation can be made.

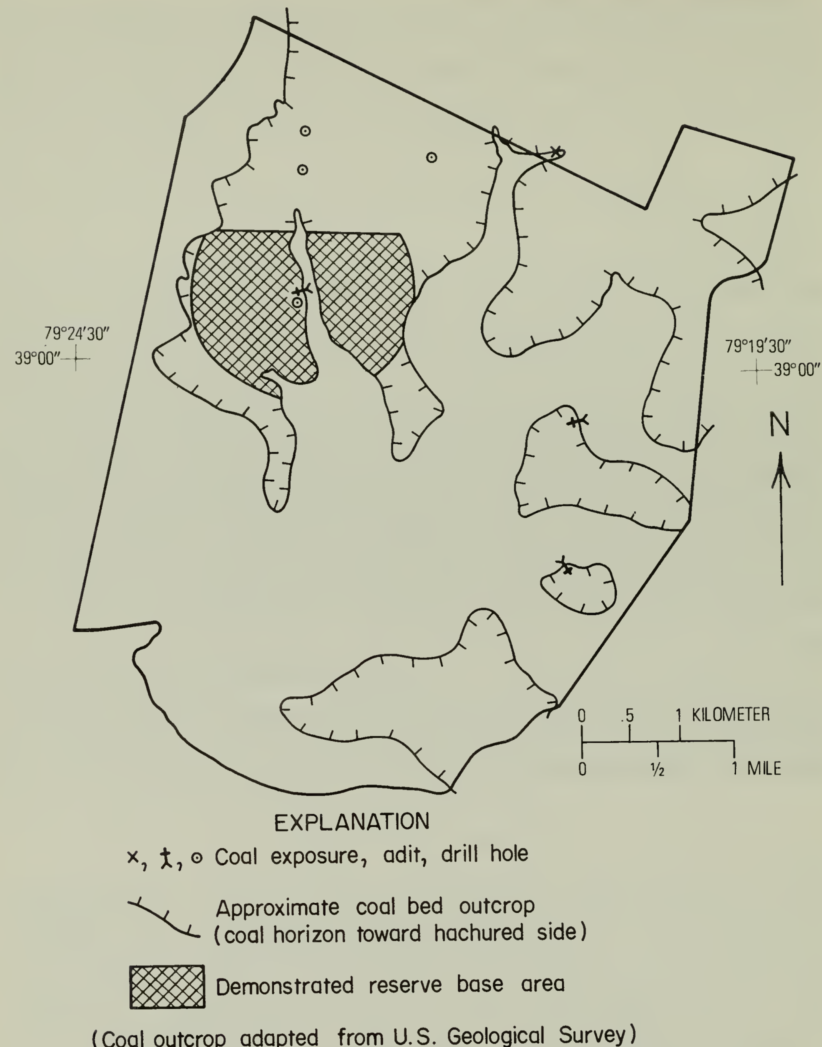


FIGURE 18.–Area of demonstrated reserve base for the Kittanning coal zone.

OIL AND GAS

Canaan Valley gas field is located on the Blackwater anticline approximately 3.2 km northwest of the Dolly Sods Wilderness Area. It was discovered in 1944 by Ohio Oil Co. Production is from Oriskany Sandstone (Lower Devonian), 20 m of which was penetrated. Total depth of the discovery well was 2,449 m (Martens, 1945). Subsequent to discovery, eight wells have been drilled in the field. As of May 1976, only one well was producing. Total estimated reserve for the field in

1974 was 0.12 billion cubic meters (Cardwell, 1974, p. 38). Current reserve estimates for this field are not available.

Red Creek field is located on the Blackwater anticline, south of Canaan Valley gas field and about 5.6 km west of the Dolly Sods area. The discovery well was drilled in 1968 by United Producers Funds, Inc., to a depth of 2,607 m. Completed in the Oriskany Sandstone in 1970, the well is still producing. One other well was drilled in this field in 1974. Although it had a show of gas, it was plugged and abandoned.

Cumulative production for both fields through 1975 is reported to be 0.16 billion cubic meters.

Leasing for oil and gas has been a common activity in the Dolly Sods area since discovery of Canaan Valley gas field in 1944. An appraisal in Forest Service files (see footnote 2) indicated that the West Virginia Coal and Timber Co. (prior owner of mineral rights in the Dolly Sods area) was approached by a company wanting oil and gas leases. Extent of leasing on Forest Service lands in the vicinity of the Dolly Sods area as of May 1976 is shown in figure 19. Active leases on private land and Forest Service land containing outstanding mineral interests has not been determined. On these lands, it is possible that considerable acreage is under active oil and gas lease.

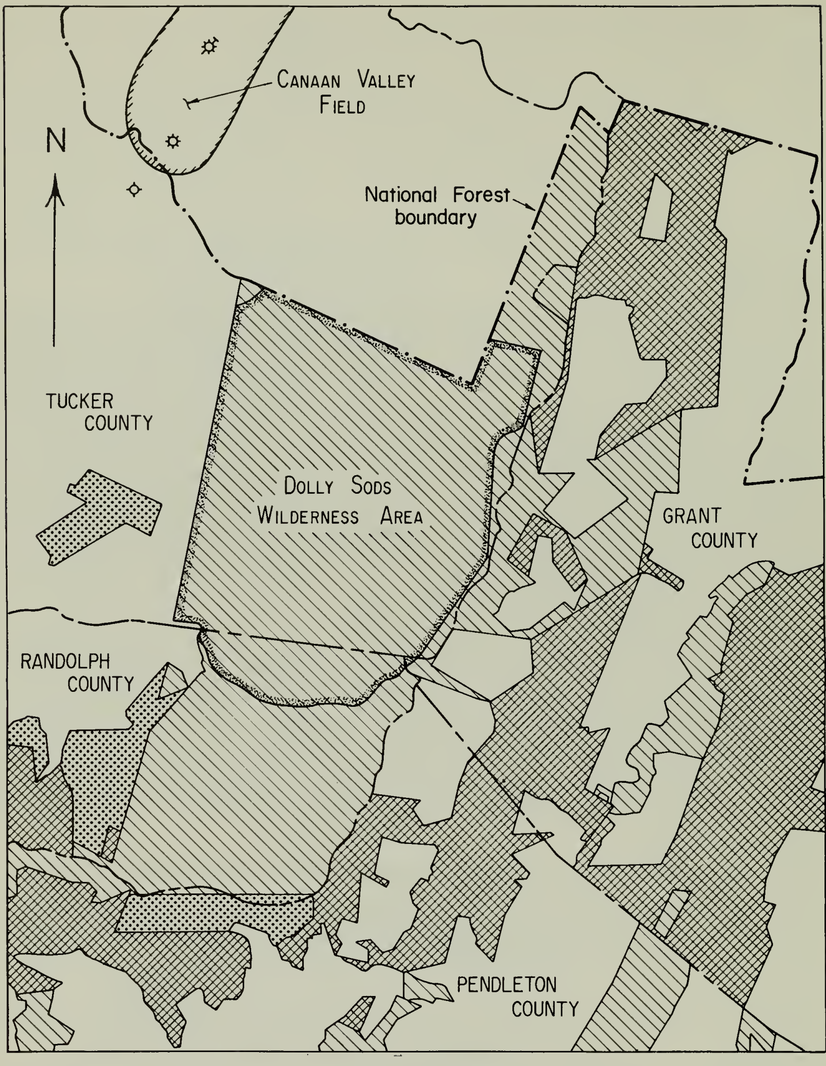
Lack of subsurface information makes assessment of oil and gas potential in the Dolly Sods area difficult. Seismic surveys have been conducted along most roads traversing the Allegheny Front east of the Wilderness Area (Dennison and Naegele, 1963, p. 39). Several decades have passed since discovery of Canaan Valley gas field, and surveys probably have been performed on areas near or adjacent to the Dolly Sods area. Proprietary industry information was not available to aid this investigation.

Two indications of oil and gas potential in the Dolly Sods area are, first, that the productive Lower Devonian horizon at nearby gas fields to the west is projected to underlie the area and, second, that the optimism of the industry is evidenced by the status of oil and gas leasing in the general area.

Possible conditions for oil and gas accumulation include those listed as follows:

1. Favorable structure or faulting at depth that could entrap hydro carbons may be present but not reflected in surface structure.
2. Stratigraphic traps may exist due to lithologic variations.
3. Pays deeper than the Lower Devonian horizon may exist.

Producing fields to the west are located on the Blackwater anticline, which has a structural closure of about 152 m. A major structural feature limits oil and gas potential in the Dolly Sods area – the axis of Stoney River syncline passes through the central part of the area (Reger and others, 1923, map II). Another limitation pointed out by Reger and others (1923, p. 265) is that formations above the Devonian crop out widely over the region, a condition that probably results in migration and loss of fluid hydrocarbons originally present.



EXPLANATION

Federal – surface and minerals

Federal – minerals outstanding

Federal – oil and gas leases

Private ownership

Gas wells – dry, abandoned, producing

(Data as of May, 1976)

FIGURE 19.–Land ownership and Federal oil and gas leases.

In conclusion, some potential may exist for natural gas in the Dolly Sods area. Although probably low, the potential remains conjectural without detailed subsurface information.

METALLIC RESOURCES

Other than small workings for iron and manganese, there has been no commercial metal mining in West Virginia (Ludlum and Arkle, 1971, p. 49). Literature and Forest Service records of prospecting permits reveal no exploration activity for metallic-mineral occurrences in or near the Dolly Sods Wilderness Area. Field reconnaissance revealed no evidence of prospecting other than for coal. No significant metallic values were found in rocks sampled in the Dolly Sods area (table 9).

Several shale units along Red Creek are described as containing iron ore (Reger and others, 1923, p. 144). Examination of the outcrops revealed scattered iron concretions in the shales. Iron content of one concretion was 32.6 percent (sample 205, table 9). Because the occurrence of concretions in the shales is sparse, they cannot be considered iron ores. Red shale in the area contains 5–10 percent ferric iron (Reger and others, 1923, p. 429). This is too low a concentration to be considered ore.

Red sandstone in the Mauch Chunk and Allegheny Formations was also sampled to test iron content. Atomic-absorption analyses (table 9) reveal iron contents of 0.4–11.1 percent. This is too low grade to be considered an economic source of iron.

NONMETALLIC RESOURCES

Commodities considered in this evaluation are shale, clay, stone, and peat.

SHALE AND CLAY

In West Virginia, the clay mine nearest to the Dolly Sods area is in Berkeley County, 120 km northeast. To evaluate ceramic properties, four shale units in the Mauch Chunk and New River and Kanawha Formations were sampled. Continuous chip samples were taken vertically through sections most representative of the units. Preliminary tests (tables 10 and 11) indicate three shale units that are suitable for good quality facing and building brick. Spectrographic analyses are reported in table 9.

TABLE 9.–*Analyses of elements in samples*

[Analyses by U.S. Bureau of Mines, Reno Metallurgy Research Center, Nev. Symbols used: >, greater than upper occur in amounts less than the lower detection limit; *, analyses not performed, Elements tested for but not analysis for manganese performed for sample 217 only: 0.20 percent]

Sample	General spectrographic analyses															
	Percent								Parts per million							
	Al	B	Ba	Ca	Fe	Mg	Na	Ti	Be	Co	Cr	Cu	Mn	Sc	Y	Mo
200	0.08	--	--	0.18	1.2	0.2	0.2	0.05	--	--	< 30	< 40	400	--	--	--
202	.1	--	--	--	.2	.003	.1	.006	--	--	< 30	< 40	< 30	--	--	--
211	.2	--	--	--	.08	.002	--	.01	--	--	< 30	< 40	--	--	--	--
216	.2	<0.01	--	<.02	.2	.004	--	.01	--	--	< 30	< 40	60	--	--	<10
225	.7	<.01	--	.1	.8	.1	.04	.03	--	--	< 30	< 40	100	--	--	--
226	<3	<.01	--	.4	1.2	.4	--	.1	--	<40	< 30	< 40	400	--	<.20	--
228	.3	--	--	--	.04	.003	--	.006	--	--	--	< 40	--	--	--	--
208	1	<.01	--	<.02	2	.1	.1	.06	--	--	< 30	< 40	500	--	--	--
217	.5	<.01	--	<.02	>3.5	.02	.1	.02	--	--	< 30	< 40	600	--	--	--
205	.03	--	--	.02	>3.5	.01	--	.001	--	--	--	< 40	600	--	--	--
204	>3	<.01	--	.02	.7	.3	.3	.07	--	--	< 30	< 40	100	--	--	--
210	>3	<.01	--	.02	1	.1	.3	.07	--	--	< 30	< 40	400	--	--	--
212	>3	<.01	--	.02	3	.3	.4	.08	--	--	30	< 40	800	--	--	--
218	>3	<.01	--	.05	>3.5	.5	.4	.08	--	--	< 30	< 40	200	--	--	--
219	>3	<.01	--	.8	>3.5	.4	.4	.08	--	--	30	< 40	300	--	--	--
224	>3	<.01	--	.1	1.5	.6	.4	.07	--	--	<30	40	300	--	--	--
201	>3	<.01	--	.1	>3.5	.07	.1	.1	10	<40	90	40	40	< 20	20	10
203	>3	<.01	<0.07	.1	>3.5	.3	.2	.1	10	< 40	90	100	< 30	< 20	20	10
206	>3	<.01	--	.1	>3.5	.09	.2	.008	10	--	70	80	60	< 20	20	10
207	>3	<.01	--	.08	>3.5	.2	.1	.1	<10	--	80	40	30	< 20	< 20	<10
209	>3	<.01	<.07	.05	2	.6	.2	.1	<10	<40	70	100	80	50	20	<10
213	>3	<.01	--	.08	>3.5	.1	.1	.1	<10	<40	40	60	30	< 20	< 20	<10
214	>3	<.01	--	<.02	1.2	.5	.1	.2	<10	<40	90	60	< 30	< 20	< 20	--
215	>3	<.01	--	.04	1.5	.5	.1	.2	<10	<40	90	70	< 30	< 20	20	--
220	>3	<.01	--	.1	>3.5	.2	.09	.2	20	<40	70	80	40	< 20	20	<10
221	>3	<.01	--	.08	>3.5	.06	.08	.1	10	<40	30	40	< 30	< 20	< 20	<10
222	>3	<.01	<.07	.2	1.2	.5	.2	.1	<10	<40	40	100	60	< 20	20	<10
223	>3	<.01	<.07	.1	1.4	.4	.2	.1	10	<40	40	100	30	20	20	<10
227	>3	<.01	<.07	.1	1.2	.3	.2	.1	10	<40	90	100	< 30	60	50	<10

[1] Representatives chip samples through interval noted.
[2] All sandstone and shale samples were tested by radiometric methods for eU_3O_8 and had values less than 20 ppm. Coal-ash samples tested less than 100 ppm eU_3O_8 by X-ray methods.

from the Dolly Sods Wilderness Area

limit of determination; <, detected but less than lower limit of determination; --, not detected and hence may only
detected: Ag, As, Au, Bi, Cd, Ca, Hf, In, Li, La, Nb, P, Pt, Re, Sb, Sn, Sr, Ta, Re, Tl, W. Atomic-absorption

General spectrographic analyses–Con.					Atomic absorption (percent)	Sample interval[1] (meters)	Sample description[2]
Parts per million							
Ni	Pb	V	Zn	Zr	Fe		
<20	--	< 60	--	< 40	11.1	2.1	Sandstone, red.
<20	--	--	--	--	.47	6.1	Sandstone, light gray to pinkish.
--	--	< 60	--	<40	*	4.6	Sandstone, white.
<20	--	< 60	--	<40	*	12.2	Sandstone, white, conglomeratic.
<20	--	<60	--	--	1.6	5.2	Sandstone, red.
<20	--	< 60	--	100	1.9	7.6	Sandstone, red and gray.
--	--	--	--	--	*	4.6	Sandstone, white.
<20	--	<60	--	80	8.1	1.2	Siltstone, red and gray, some iron concretions.
<20	--	< 60	--	< 40	11.1		Gossanlike material on sandstone joints.
--	--	--	--	< 40	32.6		Concretions in black shale.
< 20	--	< 60	--	40	*	3.0	Shale, gray metallic.
< 20	--	< 60	--	80	*	1.5	Shale, green.
< 20	--	< 60	--	80	*	4.9	Shale, black.
< 20	<100	< 60	--	80	*	5.2	Shale, red.
20	<100	< 60	--	40	*	4.3	Shale, medium gray.
< 20	--	< 60	--	< 40	*	6.1	Shale, red and green.
40	<100	< 60	< 800	40	*		Coal ash.
80	100	100	< 800	40	*		Do.
20	100	60	< 800	< 40	*		Do.
20	<100	<60	1000	< 40	*		Do.
20	100	80	< 800	40	*		Do.
40	< 100	< 60	< 800	40	*		Do.
20	< 100	90	--	40	*		Do.
20	< 100	100	--	40	*		Do.
40	< 100	< 60	800	40	*		Do.
40	< 100	< 60	< 800	< 40	*		Do.
40	200	80	< 800	< 40	*		Do.
40	200	100	< 800	40	*		Do.
80	200	100	< 800	80	*		Do.

Plastic gray clay was noted at two localities. Clay of undetermined quality, more that 20 cm thick, underlies the Kittanning coal zone at the adit on the eastern edge of Dolly Sods (fig. 13). Clay was also found beneath the largest peat bog in the northeastern part of the Dolly Sods Wilderness Area. In the center of the bog, at least 46 cm of plastic gray clay of undetermined quality underlies the peat.

Two published drill logs (Reger and others, 1923, pp. 141 and 357) show significant thicknesses of fire clay. In drill hole no. 81, 1.88 m of clay is reported underlying the Kittanning coal, and in drill hole no. 82, 0.9 m of clay underlies an uncorrelated coal above the Kittanning coal zone.

Although shales and clays of suitable quality and thickness exist as a resource in the Dolly Sods Wilderness Area, remoteness from markets, rugged terrain, and lack of accessibility limit the possibility of commercial development.

STONE

Sandstone is quarried about 6.5 km east of the Dolly Sods area. Some sandstones in the area may be suitable for construction purposes as either crushed stone, manufactured sand, riprap, or dimension stone. Most of the sandstones lack beauty in texture and grain for architectural purposes, but massive conglomeratic sandstone found in some beds may qualify as special-effect building stone.

Three samples of white, clean-looking sandstones were taken to determine their potential as a source of glass sand (table 12). The titania, alumina, and iron in these samples exceed maximum specifications of sands for flint glass or as a base for chemical manufacture (Murphy, 1975, p. 1045). However, some sandstone units may be suitable for lower grade glass.

The Greenbrier Limestone does not crop out in the Dolly Sods area. The nearest production was from a quarry, now abandoned, located about 4.8 km west on State Route 32. The Greenbrier has been described as suitable for Portland cement, road-surfacing material, and agricultural lime (Reger and others, 1923, p. 232). In the Wilderness Area, it is overlain by at least 30.5 m of the Mauch Chunk Formation and is not considered to be economical.

PEAT

An area of about 10 ha of peat accumulation is in the northeastern corner of the Dolly Sods Wilderness Area south of an abandoned beaver dam at the head of Fisher Spring Run. A test probe in the center of this bog revealed about 1.5 m of water-saturated sphagnum moss and reedsedge peat. Forest fires following logging in the area destroyed much of the original peat resource, and the probability of development is low.

TABLE 10.—*Evaluation of shale samples—slow-firing test*

[All data presented are based on laboratory tests that are preliminary in nature and will not suffice for plant or process design. Analyses by the U.S. Bureau of Mines, Tuscaloosa Metallurgy Research Center, Ala.]

Sample interval (meters)	Raw properties [1]	Slow-firing test							Potential use
		Temperature [2] °F	Munsell color	Moh's hardness	Total shrinkage (percent)	Absorption (percent)	Apparent porosity (percent)	Bulk density (g/cc)	
					Sample 212				
4.9	Water of plasticity: 15.1 percent	1800	5YR 6/6	2	5.0	15.6	29.0	1.86	Type FBS facing brick. Marginal lightweight aggregate
	Drying shrinkage: 5.0 percent	1900	5YR 5/6	3	5.0	13.0	25.4	1.96	
	Dry strength: fair	2000	5YR 4/6	3	7.5	10.3	21.1	2.04	
	Bloating test: positive	2100	2.5YR 3/4	7	7.5	6.5	14.2	2.18	
	pH: 8.7, no effervescence with HCl	2200	2.5YR 3/2	7	10.0	3.3	7.4	2.26	
		*2300	---------	--	Expanded	----	----	----	
					Sample 218				
5.2	Water of plasticity: 14.6 percent	1800	2.5YR 5/8	3	5.0	10.4	21.5	2.08	Type FBS facing brick.
	Drying shrinkage: 5.0 percent	1900	2.5YR 5/8	3	7.5	6.6	14.8	2.23	
	Dry strength: poor	2000	2.5YR 4/6	5	7.5	4.6	10.4	2.29	
	Bloating test: negative	*2100	2.5YR 3/4	7	7.5	1.6	3.9	2.37	
	pH: 8.5, no effervescence with HCl	2200	---------	--	Expanded	----	----	----	
		2300	---------	--	----	----	----	----	
					Sample 219				
4.3	Water of plasticity: 15.3 percent	1800	5YR 6/8	3	5.0	12.9	25.3	1.96	Grade SW building brick. Marginal lightweight aggregate.
	Drying shrinkage: 5.0 percent	1900	2.5YR 5/8	4	7.5	9.2	19.5	2.11	
	Dry strength: fair	2000	2.5YR 4/8	5	7.5	7.5	16.4	2.19	
	Bloating test: positive	*2100	2.5YR 4/4	7	7.5	2.6	5.8	2.24	
	pH: 8.7, no effervescence with HCl	2200	---------	--	Expanded	----	----	----	
		2300	---------	--	----	----	----	----	
					Sample 224				
6.1	Water of plasticity: 13.3 percent	1800	2.5YR 5/8	3	2.5	10.6	21.7	2.04	Not suitable for vitreous clay products.
	Drying shrinkage: 2.5 percent	1900	2.5YR 4/8	4	7.5	7.1	15.5	2.18	
	Dry strength: poor	2000	2.5YR 4/8	6	7.5	7.0	15.2	2.17	
	Bloating test: negative	*2100	---------	--	Expanded	----	----	----	
	pH: 8.9, slight effervescence with HCl	2200	---------	--	----	----	----	----	
		2300	---------	--	----	----	----	----	

[1] Tests indicate the following for all samples: working properties, short; drying defects, none.

[2] Asterisk indicates abrupt vitrification prior to reaching temperature noted.

TABLE 11.–*Evaluation of shale samples–preliminary bloating test*

[All data presented are based on laboratory tests that are preliminary in nature and will not suffice for plant or process design. Analyses by the U.S. Bureau of Mines, Tuscaloosa Metallurgy Research Center, Ala.]

Properties	Preliminary bloating test					Potential use
	Temp. °F	Absorption (percent)	Bulk density (g/cc)	Bulk density (lb/ft³)	Remarks	
Sample 212						
Crushing characteristics: angular	1,800	4.4	2.09	130.4	No expansion.	Marginal raw material for lightweight aggregate. Slightly heavy.
Particle size: ¾″ lumps and pellets	1,900	18.1	1.68	104.8	Do.	
Retention time: 15 minutes	2,000	18.8	1.63	101.7	Do.	
	2,100	16.9	1.52	94.9	Slight expansion.	
	2,200	14.3	1.18	73.6	Good pore structure.	
	2,300	12.5	1.00	62.4	Some large pores, sticky.	
Sample 219						
Crushing characteristics: angular	1,800	11.7	1.92	119.8	No expansion.	Marginal raw material for lightweight aggregate. Short firing range.
Particle size: ¾″ lumps and pellets	1,900	15.0	1.85	115.4	Do.	
Retention time: 15 minutes	2,000	13.7	1.84	114.8	Do.	
	2,100	11.1	1.73	108.0	Slight expansion.	
	2,200	8.9	1.27	79.3	Some large pores.	
	2,300	6.4	.98	61.2	Overfired, sticky.	

TABLE 12.—*Partial chemical analyses of selected sandstone samples, in percent*
[Analyses by U.S. Bureau of Mines, Reno Metallurgy Research Center, Nev.]

Sample	SiO_2	TiO_2	Al_2O_3	Fe_2O_3	K_2O	Na_2O	Sample interval [1] (feet)	Sample interval [1] (meters)
211	97.5	0.11	0.60	0.37	0.047	0.044	15	4.6
216	95.9	.10	.89	1.32	.077	.014	40	12.2
228	97.6	.11	1.40	.34	.160	.015	15	4.6

[1] Representative chip samples through interval noted.

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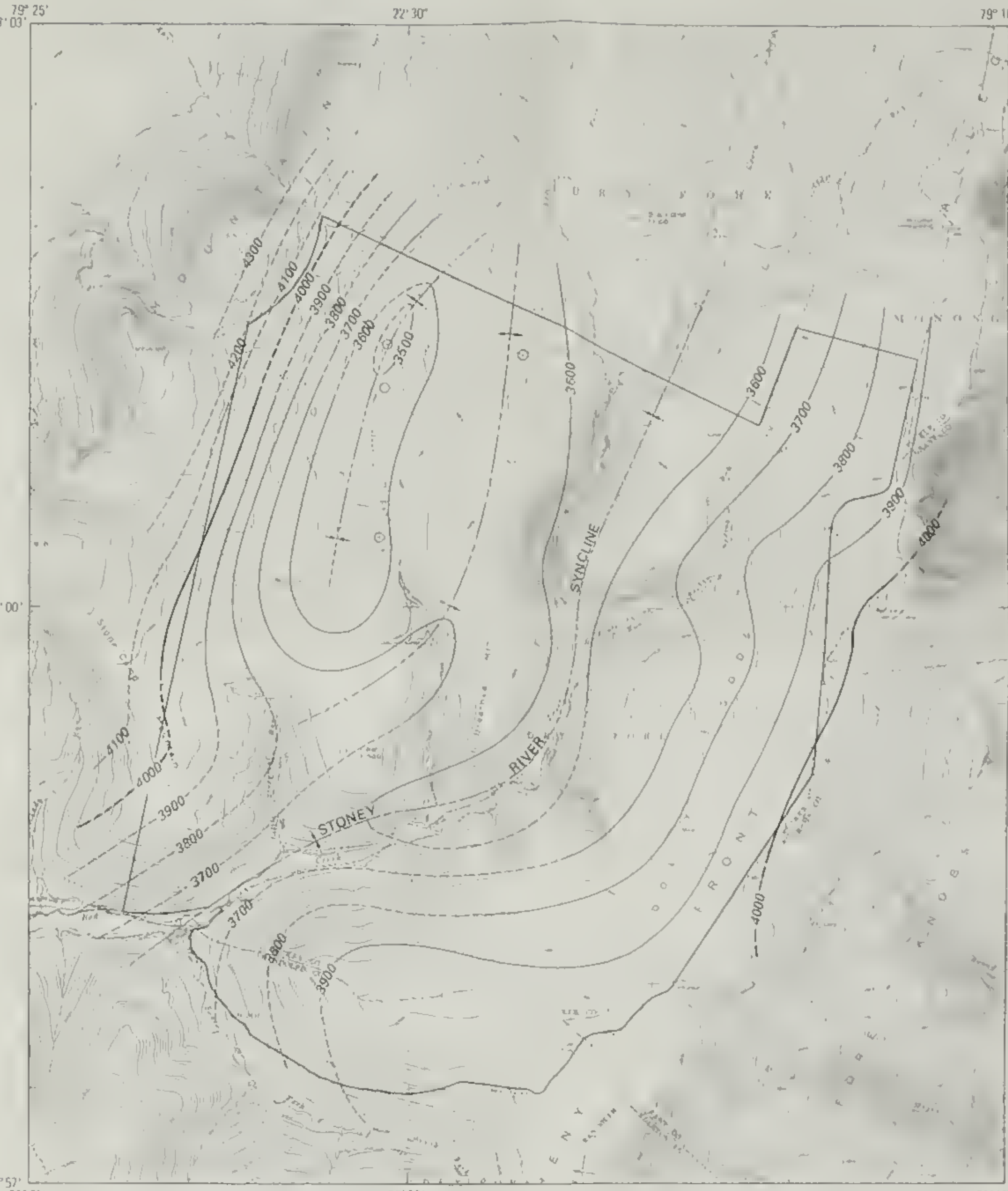


INTERIOR—GEOLOGICAL SURVEY, RESTON, VA.—1980—G79326

Geology by K. J. Englund and R. C. Warlow, 1975

SCALE 1:48 000

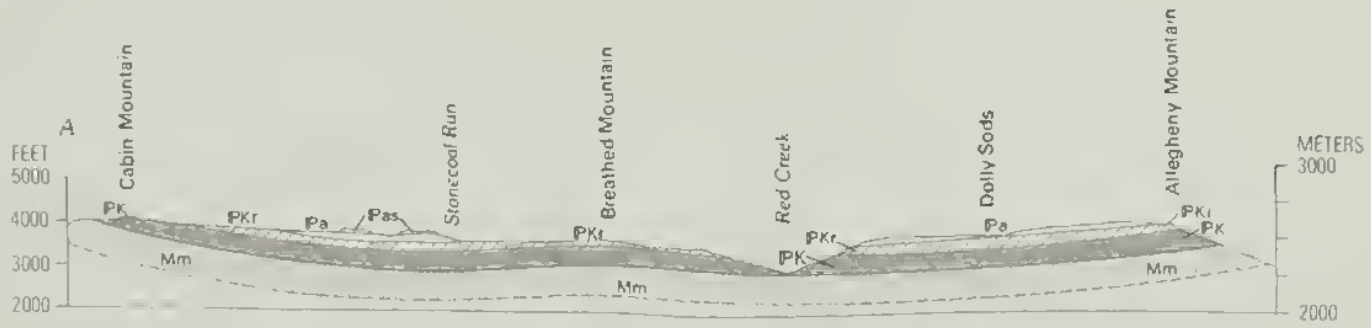
1 0 1 2 3 MILES

1 0 1 2 3 4 5 KILOMETERS

CONTOUR INTERVAL 20 AND 40 FEET
NATIONAL GEODETIC VERTICAL DATUM OF 1929

GEOLOGIC MAP OF THE DOLLY SODS WILDERNESS AREA, WEST VIRGINIA

STRUCTURE MAP OF THE DOLLY SODS WILDERNESS AREA, WEST VIRGINIA



EXPLANATION

Qp	Peat	QUATERNARY
Qal	Alluvium	QUATERNARY
Pc	Conemaugh Formation	PENNSYLVANIAN
Pas / Pa / K	Allegheny Formation—Pas sandstone member; k, Kittanning coal zone	PENNSYLVANIAN
PKr / PK / C, S	Kanawha and New River Formations, undivided. PKr, Roaring Creek Sandstone of White (1903); C, coal bed; S, Sewell(?) coal bed	PENNSYLVANIAN
Mm	Mauch Chunk Formation	MISSISSIPPIAN

Contact—Dashed where approximately located

Coal bed—Dashed where approximately located

Anticline—Showing crestline. Dashed where approximately located

Syncline—Showing troughline. Dashed where approximately located

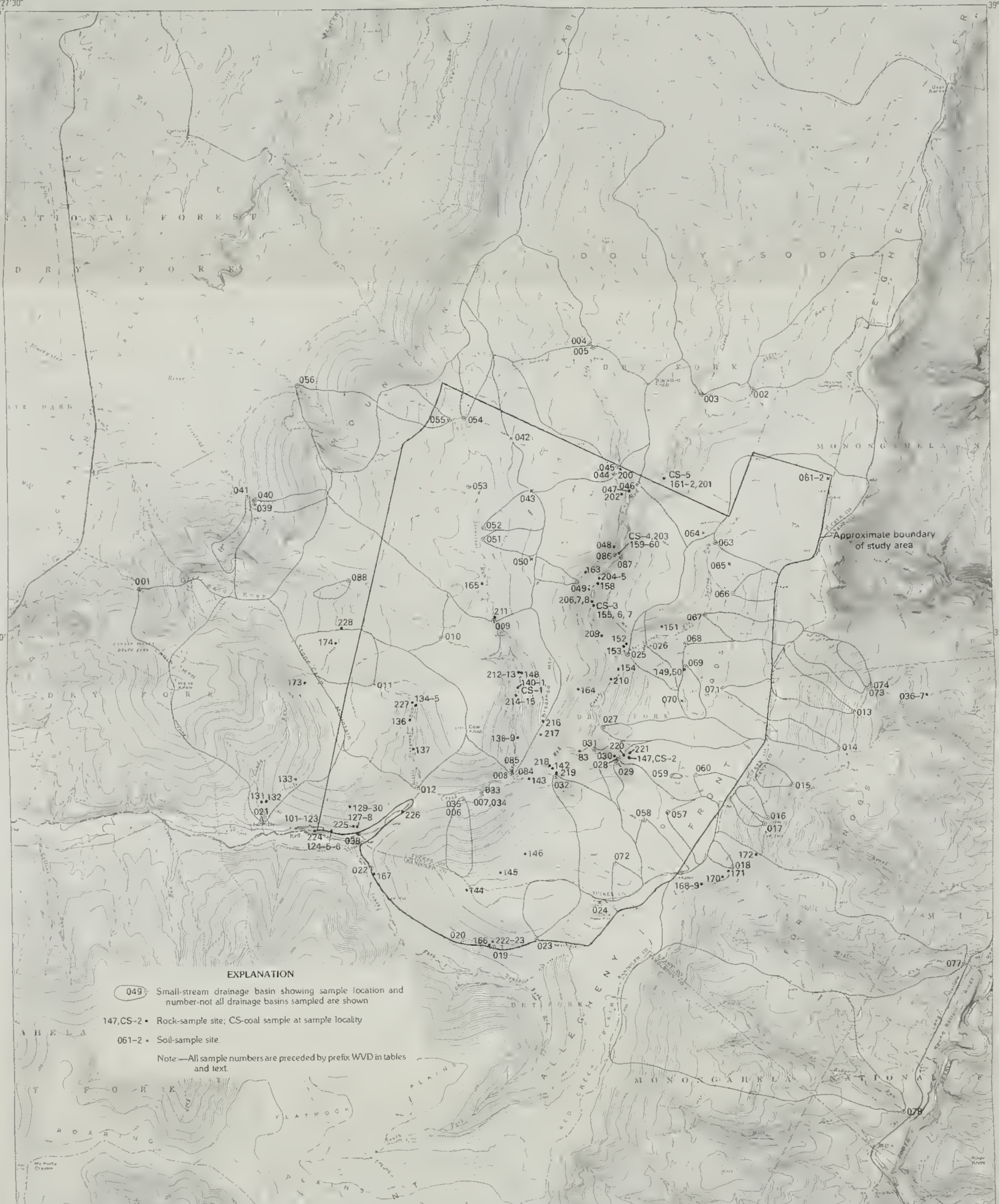
Structure contour—Drawn on top of Roaring Creek Sandstone of White (1903). Dashed where projected from other beds. Contour interval 100 feet

Caved adit

Prospect or outcrop

Core hole

GEOLOGIC MAP, STRUCTURE CONTOUR MAP, AND GENERALIZED CROSS SECTION OF DOLLY SODS WILDERNESS AREA, GRANT, RANDOLPH, AND TUCKER COUNTIES, WEST VIRGINIA



Base from U S Geological Survey
Blackwater Falls, W Va, 1968, Hopeville, W Va, 1969
Laneville, W Va, 1969, Blackbird Knob, W Va, 1967

SCALE 1:48 000

1 0 1 2 3 MILES

1 0 1 2 3 4 5 KILOMETERS

CONTOUR INTERVAL 20 AND 40 FEET
NATIONAL GEODETIC VERTICAL DATUM OF 1929

INTERIOR—GEOLOGICAL SURVEY RESTON VA—1980—G79326

MAP OF THE DOLLY SODS WILDERNESS AREA, SHOWING STREAM-SEDIMENT, SOIL, AND ROCK-SAMPLE LOCALITIES